S. HRG. 101-168

ENERGY EFFICIENCY AND RENEWABLE ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

S. 488

TO PROVIDE FEDERAL ASSISTANCE AND LEADERSHIP TO A PROGRAM OF RESEARCH, DEVELOPMENT, AND DEMONSTRATION OF RENEWABLE ENERGY AND ENERGY EFFICIENCY TECHNOLOGIES, AND FOR OTHER PURPOSES

S. 964

TO AUTHORIZE APPROPRIATIONS TO THE DEPARTMENT OF ENERGY FOR CIVILIAN ENERGY PROGRAMS FOR FISCAL YEAR 1990 AND FISCAL YEAR 1991, AND FOR OTHER PURPOSES

JUNE 15, 1989

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ENERGY EFFICIENCY AND RENEWABLE ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

THURSDAY, JUNE 15, 1989

U.S. Senate,
Subcommittee on Energy Research and Development,
Committee on Energy and Natural Resources,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:35 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Wendell H. Ford presiding.

OPENING STATEMENT OF HON. WENDELL H. FORD, U.S. SENATOR FROM KENTUCKY

Senator Ford. Good morning, ladies and gentlemen. This morning the subcommittee is holding the hearing on Senator Fowler's bill, S. 488, and on the President fiscal year 1990 budget request for renewable energy and energy efficiency research, development, and demonstration. I am very pleased to be a cosponsor of Senator Fowler's bill, as are Senators Johnston, Hatfield, Domenici, Murkowski, Wirth, Bumpers, Metzenbaum, Conrad, Bingaman and 15 other Senators. It is obvious that Senator Fowler has put together a good bill with these cosponsors. This is a bill that the Administration can support with only minor changes. It is a bill that I believe the Administration will fully support.

I congratulate Senator Fowler on his work on this bill. A companion bill is moving in the House, and we should keep this bill moving in the Senate.

This bill sets realistic goals for the renewable energy RD&D program so we can measure the progress made with the money we appropriate. The bill provides responsible multiyear authorization levels so there can be some stability in funding and stability in planning. It involves private industry in commercialization of renewable energy and energy efficiency technologies in a manner that follows the example of the Clean Coal Technology Program.

These are reasonable provisions. The bill has bipartisan cosponsorship. I hope we will be able to pass it out and to pass it very quickly.

[The texts of S. 488 and S. 964 and prepared statements for the record from Senators McClure and Burns follow:]

101st CONGRESS
1st Session

S. 488

To provide Federal assistance and leadership to a program of research, development, and demonstration of renewable energy and energy efficiency technologies, and for other purposes.

IN THE SENATE OF THE UNITED STATES

March 1 (legislative day, January 3), 1989

Mr. Fowler (for himself, Mr. Bumpers, Mr. Ford, Mr. Metzenbaum, Mr. Bingaman, Mr. Conrad, Mr. Kerry, and Mr. Wirth) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

---

A BILL

To provide Federal assistance and leadership to a program of research, development, and demonstration of renewable energy and energy efficiency technologies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be referred to as the "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989".

SEC. 2. PURPOSE.

It is the purpose of this Act to direct the Secretary of Energy, acting in accordance with authority contained in the Federal Nonnuclear Energy Research and Development Policy Act of 1974 (42 U.S.C. 5901–5920) and other law applicable to the Secretary, to pursue an aggressive national program of research, development, and demonstration of renewable energy and energy efficiency technologies in order to ensure a stable and secure future energy supply by—

(1) providing a long-term stable environment for renewable energy and energy efficiency technology research and development activities through the establishment of long-term goals and multiyear funding levels;

(2) directing the Secretary to undertake initiatives to hasten the commercialization in the near term of renewable energy and energy efficiency technologies; and

(3) fostering collaborative research and development efforts involving the private sector through government support of a vigorous program of innovative joint research and development venture projects.

SEC. 3. DEFINITIONS.

As used in this Act the term—

(1) "Secretary" means the Secretary of Energy; and

(2) "joint research and development venture" means a joint research and development venture under the National Cooperative Research Act of 1984 (98 Stat. 1815).

SEC. 4. NATIONAL GOALS AND MULTI-YEAR FUNDING FOR FEDERAL WIND, PHOTOVOLTAICS AND SOLAR THERMAL PROGRAMS.

(a) NATIONAL GOALS.—The following are declared to be the national goals for the wind, photovoltaics, and solar thermal energy programs being carried out by the Secretary:

(1) WIND.—(A) In general, the goals for the Wind Energy Research Program include improving design methodologies and developing more reliable and efficient wind turbines to increase the cost competitiveness of wind energy. Research efforts shall emphasize—

(i) activities that address near-term technical problems and permit exploitation of market opportunities of the wind energy industry;

(ii) developing advanced airfoils and variable speed generators to increase wind turbine output and reduce maintenance costs by decreasing structural stress and fatigue;

(iii) increasing the basic knowledge of aerodynamics, structural dynamics, fatigue, and electrical systems interactions as applied to wind energy technology; and

(iv) improving the compatibility of electricity produced from windfarms with conventional utility needs.

(B) Specific goals for the Wind Energy Research Program shall be to—

(i) reduce average wind energy costs to 3 to 5 cents per kilowatt hour by 1995;

(ii) reduce capital costs of new wind energy systems to $500 to $750 per kilowatt of installed capacity by 1995;

(iii) increase installed wind generating capacity to 4,000 to 8,000 megawatts by 1995;

(iv) reduce operation and maintenance costs for wind energy systems to less than 1 cent per kilowatt hour by 2000; and

(v) increase capacity factors for new wind energy systems to 25 to 30 per centum by 1995.

(2) PHOTOVOLTAICS.—(A) In general, the goals of the Photovoltaic Energy Systems Program shall include improving the reliability and conversion efficiencies and lowering the costs of photovoltaic conversion. Research efforts shall emphasize advancements in the

performance, stability, and durability of photovoltaic materials.

(B) Specific goals of the Photovoltaic Energy Systems Program shall be to—

(i) improve operational reliability of photovoltaic modules to thirty years by 1995;

(ii) increase photovoltaic conversion efficiency of new photovoltaic amorphous silicon modules to 15 per centum by 1995;

(iii) decrease new photovoltaic module direct manufacturing costs to $800 per kilowatt by 1995; and

(iv) increase installed capacity of photovoltaic electric power production capacity to 100 to 200 megawatts by 1991.

(3) SOLAR THERMAL.—(A) In general, the goal of the Solar Thermal Energy Systems Program shall be to advance research and development to a point where solar thermal technology is cost-competitive with conventional energy sources and to promote the integration of this technology into the production of industrial process heat and the conventional utility network. Research and development shall emphasize development of a thermal storage technology to provide capacity for shifting power to periods of demand when

full insolation is not available; improvement in receivers, energy conversion devices, and innovative concentrators using stretch membranes, lenses and other materials; and exploration of advanced manufacturing techniques.

(B) Specific goals of the Solar Thermal Energy Systems Program shall be to—

(i) reduce solar thermal costs for industrial process heat to $9 per million Btu; and

(ii) reduce average solar thermal costs for electricity to 4 to 5 cents per kilowatt hour.

(4) OTHER TECHNOLOGIES.—The President's budget request for fiscal year 1991 shall contain the Secretary's recommendations for specific cost, installed capacity, and other pertinent goals for 1995 for Department of Energy research, development, and demonstration programs in Biofuels Energy Systems, Solar Buildings Energy Systems, Ocean Energy Systems and Geothermal Energy.

(b) AMENDED GOALS.—Whenever the Secretary determines that any of the goals established under this section is no longer appropriate, he shall notify Congress of the reason for the determination and provide an amended goal that is consistent with the purpose stated in section 2.

(c) AUTHORIZATIONS.—There is authorized to be appropriated to the Secretary—

(1) for the Wind Energy Research Program, an amount not to exceed $11,000,000 in fiscal year 1991; $12,000,000 in fiscal year 1992; and $12,000,000 in fiscal year 1993;

(2) for the Photovoltaic Energy Systems Program, an amount not to exceed $39,000,000 in fiscal year 1991; $40,000,000 in fiscal year 1992; and $40,000,000 in fiscal year 1993;

(3) for the Solar Thermal Energy Systems Program, an amount not to exceed $16,000,000 in fiscal year 1991; $17,000,000 in fiscal year 1992; and $17,000,000 in fiscal year 1993;

(4) for the Biofuels Energy Systems Program, an amount not to exceed $16,000,000 in fiscal year 1991; $17,000,000 in fiscal year 1992; and $17,000,000 in fiscal year 1993;

(5) for the Solar Buildings Energy Systems Program, an amount not to exceed $7,000,000 in fiscal year 1991; $8,000,000 in fiscal year 1992; and $8,000,000 in fiscal year 1993;

(6) for the Ocean Energy Systems Program, an amount not to exceed $4,000,000 in fiscal year 1991;

$5,000,000 in fiscal year 1992; and $5,000,000 in fiscal year 1993; and

(7) for the Geothermal Energy Program, an amount not to exceed $20,000,000 in fiscal year 1991; $22,000,000 in fiscal year 1992; and $25,000,000 in fiscal year 1993.

(d) REPORT ON OPTIONS.—On or before May 1, 1991, the Secretary shall submit to Congress a report analyzing options available to the Secretary under existing law to accelerate the timely commercialization of wind, photovoltaic, solar thermal, biofuels, biomass, solar buildings, ocean and geothermal renewable energy technologies through emphasis on development and demonstration assistance to specific technologies in the research, development, and demonstration programs of the Department of Energy that are near commercial application.

SEC. 5. ENERGY EFFICIENCY RESEARCH AND DEVELOPMENT.

(a) NEW INITIATIVES.—The President's budget request for fiscal years 1991 and 1992 shall include the Secretary's recommendations of amounts to be set aside for new initiatives in energy efficiency research, development, and demonstration. Funds made available for new initiatives shall supplement and not supplant funds available to complete ongoing energy efficiency research, development, and demonstration projects supported in whole or in part by the Secretary during fiscal year 1990. Funds made available for new initiatives shall be used by the Secretary to support the most promising and deserving new ideas in energy efficiency research, development, and demonstration brought to the attention of the Secretary during the previous fiscal year.

(b) AUTHORIZATIONS.—There is authorized to be appropriated to the Secretary—

(1) for transportation energy research, development, and demonstration, an amount not to exceed $58,000,000 in fiscal year 1991; $63,000,000 in fiscal year 1992; and $65,000,000 in fiscal year 1993;

(2) for industrial energy efficiency research, development, and demonstration, an amount not to exceed $42,000,000 in fiscal year 1991; $45,000,000 in fiscal year 1992; and $47,000,000 in fiscal year 1993;

(3) for building and community systems energy efficiency research, development, and demonstration, an amount not to exceed $42,000,000 in fiscal year 1991; $45,000,000 in fiscal year 1992; and $53,000,000 in fiscal year 1993;

(4) for multi-sector energy efficiency research, development, and demonstration, an amount not to exceed $33,000,000 in fiscal year 1991; $36,000,000 in fiscal year 1992; and $37,000,000 in fiscal year 1993; and

(5) for energy efficiency research, development, and demonstration policy and management, an amount not to exceed $1,600,000 in fiscal year 1991; $1,700,000 in fiscal year 1992; and $1,800,000 in fiscal year 1993.

SEC. 6. JOINT RESEARCH AND DEVELOPMENT VENTURES.

(a) FINDINGS AND PURPOSE.

(1) FINDINGS.—For purposes of this section, Congress finds that joint research and development ventures can—

(A) improve coordination in technology development among firms in industries attempting to commercialize renewable energy and energy efficiency technologies;

(B) assist in setting national standards to improve the operation of markets for these technologies; and

(C) enhance the ability of domestic firms to compete with foreign enterprises in sales of renewable energy and energy efficiency technologies.

(2) PURPOSE.—The purpose of this section is to direct the Secretary of Energy to make use of joint research and development ventures to further commer-

cialization of renewable energy and energy efficiency technologies.

(b) VENTURES.—(1) The Secretary shall establish six joint research and development ventures under subsection (c). Each joint research and development venture under this section shall include manufacturing firms, investors, an advisory committee appointed in accordance with this section, and such other participation as the Secretary deems appropriate to achieve the purposes of this section. Any facilities constructed under this section shall be located in the United States, Puerto Rico, the Virgin Islands, or the territories and possessions of the United States.

(2) COST SHARING.—The Secretary shall require that at least 30 per centum of all costs of any joint research and development venture under this section be provided from non-Federal sources.

(3) Before establishing the joint research and development ventures under paragraph (1), the Secretary shall consult with, and take into consideration the recommendations of, the Advisory Committee on Renewable Energy and Energy Efficiency Technology under paragraph (4).

(4) ADVISORY COMMITTEE.—(A) The Secretary shall establish an Advisory Committee on Renewable Energy and Energy Efficiency Technology (hereafter referred to as the 'Advisory Committee') to assist the Secretary in carrying out

his responsibilities under this section. The secretary shall appoint members to the Advisory Committee, including at least one member representing—

(i) the Secretary of Commerce;

(ii) the Secretary of Housing and Urban Development;

(iii) the Solar Energy Research Institute;

(iv) the Electric Power Research Institute;

(v) the National Institute of Building Sciences;

(vi) associations of firms in each of the major renewable energy manufacturing industries; and

(vii) associations of firms in each of the major energy efficiency manufacturing industries.

(B) The Advisory Committee, within one hundred and twenty days after its formation, shall provide the Secretary with recommendations for the establishment of joint ventures under paragraph (1) and shall advise the Secretary from time to time about the implementation of such ventures. Recommendations of the Advisory Committee shall be available to the public.

(5) REPORT TO CONGRESS.—Not later than one hundred and eighty days after the date of the enactment of this section the Secretary shall publish plans to implement this section and report to Congress on such plans.

(c) TECHNOLOGIES.—(1) PHOTOVOLTAICS TECHNOLOGY.—(A) The Secretary shall establish and provide financial assistance to a joint research and development venture for the demonstration of photovoltaic conversion of solar energy in accordance with the provisions of this paragraph.

(B) The purpose of the venture under established under this paragraph shall be to design, test and demonstrate systems employing critical enabling technologies for photovoltaic conversion of solar energy so as to achieve, to the maximum extent practicable, the goals of the Photovoltaic Energy Systems Program set forth in section 304(a)(2), as those goals may be amended under section 304(b). The joint research and development venture under this paragraph may emphasize production, distribution, storage, or end use of electricity from photovoltaic conversion of solar energy or any combination thereof, and may include systems employing other sources of energy in addition to photovoltaic conversion of solar energy.

(C) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, the Secretary shall consider the recommendations of the Advisory Subcommittee on Photovoltaic Energy Technology established under subparagraph (D).

(D) The Secretary shall establish an Advisory Subcommittee on Photovoltaic Energy Technology to assist the Secretary in carrying out his responsibilities with respect to the joint venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following:

(i) firms in the photovoltaic manufacturing industry;

(ii) the Director of the Agency for International Development; and

(iii) the Director of the Export-Import Bank.

(E) There is authorized to be appropriated to the Secretary a total of not more than $1,200,000 for each of the fiscal years 1991, 1992, and 1993 to carry out this paragraph.

(2) WIND ENERGY TECHNOLOGY.—(A) The Secretary shall establish and provide financial assistance to a joint research and development venture for the demonstration of the conversion of wind energy in accordance with the provisions of this paragraph.

(B) The purpose of the venture established under this paragraph shall be to design, test and demonstrate systems employing critical enabling technologies for the conversion of wind energy so as to achieve, to the maximum extent practicable, the goals of the Wind Energy Research Program set forth in section 304(a)(1), as those goals may be amended under section 304(b). The venture under this paragraph may emphasize production, distribution, storage, or end use of wind energy or any combination thereof and may include systems employing other sources of energy in addition to wind energy.

(C) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, the Secretary shall consider the recommendations of the Advisory Subcommittee on Wind Energy Technology established under subparagraph (D).

(D) The Secretary shall establish an Advisory Subcommittee on Wind Energy Technology to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following—

(i) firms in the wind energy equipment manufacturing industry;

(ii) the Director of the Agency for International Development; and

(iii) the Director of the Export-Import Bank.

(E) There is authorized to be appropriated to the Secretary a total of not more than $1,200,000 for each of the fiscal years 1991, 1992, and 1993 to carry out this paragraph.

(3) SOLAR THERMAL TECHNOLOGY.—(A) The Secretary shall establish and provide financial assistance to a joint research and development venture for the demonstration of the use of solar thermal energy in accordance with the provisions of this paragraph.

(B) The purpose of the joint research and development venture established under this paragraph shall be to design, test, and demonstrate critical enabling technologies for the use of solar thermal energy so as to achieve, to the maximum extent practicable, the goals of the Solar Thermal Energy Systems Program set forth in section 304(a)(3), as those goals may be amended under section 304(b). The venture under this paragraph may emphasize production, distribution, storage, or end use of solar thermal energy or any combination thereof and may include systems employing other sources of energy in addition to solar thermal energy.

(C) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, the Secretary shall consider the recommendations of the Advisory Subcommittee on Solar Thermal Energy Technology established under subparagraph (D).

(D) The Secretary shall establish an Advisory Subcommittee on Solar Thermal Energy Technology to assist the Secretary in carrying out his responsibilities with respect to the joint venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following—

(i) firms in the solar thermal manufacturing industry;

(ii) the Director of the Agency for International Development;

(iii) the Director of the Export-Import Bank; and

(iv) the Gas Research Institute.

(E) There is authorized to be appropriated to the Secretary a total of not more than $900,000 for each of the fiscal years 1991 through 1993 to carry out this paragraph.

(4) FACTORY-MADE HOUSING.—(A) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary deems appropriate in order to estabish at least three regional projects to demonstrate techniques to improve the energy performance of factory-made housing offered by United States firms. In locating the projects under this paragraph, the Secretary shall consider regional differences in housing needs, housing design, con-

struction technique, marketing practices, and construction materials.

(B) The projects established pursuant to this paragraph shall be designed to demonstrate state-of-the-art product quality, energy efficiency, and adaptability to renewable forms of energy of factory-made housing offered for sale in the United States. The projects shall be structured to demonstrate improvements in housing design, fabrication, delivery systems, construction processes, marketing, and product export techniques.

(C) The demonstration strategy under this paragraph shall be guided by—

(i) a detailed characterization of the needs of the homebuilding industry;

(ii) a close working relationship with all sectors of the homebuilding industry; and

(iii) coordination among the projects to pool and conserve resources.

(D) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, and in selecting projects under this paragraph, the Secretary shall consider the recommendations of the Advisory Subcommittee on Energy Performance in Factory-Made Housing established under subparagraph (E).

((E) The Secretary shall establish an Advisory Subcommittee on Energy Performance in Factory-Made Housing to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following:

(i) the National Association of Home Builders;

(ii) the National Laboratories of the Department of Energy; and

(iii) the National Institute of Standards and Technologies.

(F) There is authorized to be appropriated to the Secretary a total of not more than $5,000,000 for each of the fiscal years 1991, 1992, and 1993 to carry out this paragraph.

(5) ADVANCED DISTRICT COOLING TECHNOLOGY.—(A) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary deems appropriate in order to develop advanced district cooling technologies that are applicable in cities with high cooling loads.

(B) The purpose of the joint venture estabished under this paragraph is to develop technical strategies for decreasing the capital cost and increasing the energy efficiency of major district heating and cooling system components and to assist in making district cooling available to local governments.

(C) The Secretary shall select three cities for application of advanced district cooling technologies developed by the joint venture established under this paragraph. The activities to be carried out in such application shall include district cooling assessment, feasibility, and engineering design studies.

(D) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, and in selecting the cities under subparagraph (C), the Secretary shall consider the recommendations of the Advisory Subcommittee on Advanced District Cooling Technology established under subparagraph (E).

(E) The Secretary shall establish an Advisory Subcommittee on Advanced District Cooling Technology to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following:

(i) firms manufacturing district cooling equipment; and

(ii) the National League of Cities.

(F) There is authorized to be appropriated for each of the fiscal years 1991, 1992, and 1993 not more than $1,000,000 per year to carry out this paragraph.

(6) EXPORT TECHNOLOGY PROJECTS.—(A) For purposes of this paragraph Congress finds that—

(i) the United States has several advanced energy efficiency and renewable energy technologies that lack only sufficient coordination, support, and emphasis to become important export items capable of reducing the United States trade deficit;

(ii) a major barrier to export of energy efficiency and renewable energy technology is the lack of information on overseas markets and technology development by foreign competitors;

(iii) the industry that markets energy efficiency technology is highly fragmented, and the renewable energy industry is comprised of small firms that lack the necessary resources to identify and target overseas markets; and

(iv) a joint research and development venture is needed to bring together a broad array of manufacturing firms, financial institutions, and Federal agencies to identify and develop promising technologies and export markets for energy efficiency and renewable energy technologies.

(B) The Secretary shall establish and provide financial assistance to a joint research and development venture with such specialized private firms and investors as the Secretary determines appropriate for the purpose of commercializing and marketing domestically developed energy efficiency and renewable energy technology in order to enhance sales of products developed from such technology relative to foreign-made products.

(C) In preparing solicitations and evaluating proposals received for the joint research and development venture to be established under this paragraph, and in designing the joint venture under this paragraph, the Secretary shall consider the recommendations of the Advisory Subcommittee on Renewable Energy and Energy Efficiency Technology Exports established under subparagraph (D).

(D) The Secretary shall establish an Advisory Subcommittee on Renewable Energy and Energy Efficiency Technology Exports to assist the Secretary in carrying out his responsibilities with respect to the joint research and development venture established under this paragraph. Such subcommittee shall include such members of the Advisory Committee as the Secretary deems appropriate and, in addition, at least one member representing each of the following:

(i) the Director of the Agency for International Development;

(ii) the Director of the Export-Import Bank;

(iii) the United States Export Council for Renewable Energy;

(iv) the National Laboratories of the Department of Energy.

(E) There is authorized to be appropriated to the Secretary to carry out the purposes of this paragraph a total amount for each of the fiscal years 1991, 1992, and 1993—

(i) not to exceed $5,000,000 with respect to renewable energy activities under this paragraph; and

(ii) not to exceed $5,000,000 with respect to energy efficiency activities under this paragraph.

(d) SECRETARIAL DISCRETION.—(1) If the Secretary, based on the recommendations of the Advisory Committee under subsection (b)(4)(B), or of any subcommittee thereof provided under subsection (c), with respect to a technology described in paragraph (1), (2), (3), (4), (5), or (6) of subsection (c), determines, that—

(A) there is insufficient private sector interest in a joint research and development venture for the demonstration of such technology to satisfy the requirement of subsection (b)(2);

(B) carrying out a joint research and development venture for the demonstration of such technology will not further the purposes of this Act; or

(C) timely commercialization of the technology to be demonstrated will not be advanced by the venture, then the Secretary shall not be subject to the requirements of this section with respect to the technology described in such paragraph.

(2) The Secretary shall notify Congress of any determination under paragraph (1) and provide a written explanation of the reasons for the determination. Promptly thereafter, the Secretary shall consult with the Advisory Committee, and, based on the recommendations of such Committee, shall promptly transmit to Congress a plan for the establishment of a substitute joint research and development venture to demonstrate, consistent with this section, an alternative renewable energy or energy efficiency technology so as to accomplish the purposes of this Act. Any unexpended funds authorized to be appropriated under subsection (c) for the joint research and development venture with respect to which a determination is made under paragraph (1) may be used for a substitute joint research and development venture established under this paragraph.

(3) When thirty calendar days have elapsed after transmittal of the plan under paragraph (2), the Secretary shall proceed with the joint research and development venture described in his plan as if such venture were required under subsection (c).

(e) ADDITIONAL COMMERCIALIZATION PROPOSALS.—(1) The President's budget request for fiscal year 1992 shall include the Secretary's recommendations for at least one proposed proof-of-concept or near-commercial demonstration project in each of the categories represented by sections 4(a)(1), (2), and (3). Such projects shall require funding or in-kind contributions from private sources in support of at least 30 per centum of total project costs. Each proposed project shall be described in sufficient detail to support congressional authorization and solicitation of bids for construction of necessary facilities.

(2) A list and description of alternative project plans under this subsection shall be submitted in President's fiscal year 1991 budget request. Such plans shall require funding or in-kind contributions from private sources in support of at least 30 per centum of total project costs.

(3) In selecting proposed projects under this subsection, the Secretary shall take into account the extent to which such projects will contribute to earlier commercialization of key technologies within such categories than might occur

without Federal support under this subsection and the extent to which such projects will contribute to the competitiveness of United States firms engaged in international trade in renewable energy technologies.

SEC. 7. RENEWABLE ENERGY EXPORTS.

(a) FINDINGS AND PURPOSE.—(1) For purposes of this section, Congress finds that—

(A) among the major problems in promoting exports of renewable energy technology are the lack of available information on overseas markets and the absence of financing for the purchase of the technologies; and

(B) the Committee on Renewable Energy, Commerce, and Trade ("CORECT") established under the Renewable Energy Industry Development Act (Public Law 98–370) currently coordinates Federal Government activities to promote renewable energy exports.

(2) The purpose of this section is to evaluate current efforts to promote exports of renewable energy technology, to establish a joint Government-industry plan to identify promising technologies and increase the financing available for exports of renewable energy technologies, to target potential markets for these technologies, and to authorize funding of these activities.

(b) ANNUAL REPORT.—The Committee on Renewable Energy, Commerce, and Trade shall annually report to Congress. Each report submitted under this subsection shall describe the actions of each agency represented by a member of the Committee on Renewable Energy, Commerce, and Trade taken during the previous fiscal year to achieve the purposes of such Committee and of this section. Such report shall describe the exports of renewable energy technology that have occurred as a result of such agency actions.

(c) PLAN.—(1) The Committee on Renewable Energy, Commerce, and Trade shall—

(A) establish, in consultation with representatives of affected industries, a plan to maintain or increase the market share of the United States in international trade in renewable energy technologies, including technologies for production of alcohol fuels, biomass energy, geothermal energy, wood energy and in technologies for passive solar energy conversion, photovoltaics, solar thermal energy conversion and wind energy conversion, and include in such plans guidelines for agencies that are members of the Committee with respect to the financing of exports of such renewable energy technologies;

(B) develop, in consultation with representatives of affected industries, administrative guidelines for Federal export loan programs to simplify application by firms seeking export assistance for renewable energy technologies from agencies implementing such programs; and

(C) target renewable energy technology markets for primary emphasis by Federal export loan programs, development programs, and private sector assistance programs.

(2) The Committee on Renewable Energy, Commerce, and Trade shall include a description of the plan established under paragraph (1) in no later than the second report submitted under subsection (b), and shall include in subsequent reports a description of any modifications to such plan and of the progress in implementing the plan.

(d) AUTHORIZATIONS.—There is hereby authorized to be appropriated to the Secretary for activities of the Committee on Renewable Energy, Commerce, and Trade an amount not to exceed—

(1) $1,200,000 in fiscal year 1991;

(2) $1,500,000 in fiscal year 1992; and

(3) $1,800,000 in fiscal year 1993.

SEC. 8. RENEWABLE ENERGY.

(a) DISSEMINATION OF INFORMATION.—Section 523 of the National Energy Conservation Policy Act (42 U.S.C. 8243) is amended by adding a new subsection (d) as follows:

"(d) In order to more widely disseminate information about the program under this part and under part 3 and the benefits of solar heating and cooling technology, the Secretary shall establish a program which includes site visits and technical briefings, to disseminate such information to Federal procurement officers and Federal loan officers that shall include site visits and technical briefings. The Secretary shall utilize available funds for the program under this subsection.".

(b) DEPARTMENT OF DEFENSE HOUSING.—Section 2857(b)(1) of title 10, United States Code, is amended by striking "significant savings of fossile-fuel-derived energy" and inserting in lieu thereof "reduced energy costs".

(c) OVERSEAS PRIVATE INVESTMENT CORPORATION LOANS.—Section 234(e) of the Foreign Assistance Act of 1961 is amended—

(1) in the first sentence, by inserting after "cooperatives" the following: "and including the initiation of incentives, grants, and studies for renewable energy and other small business activities"; and

(2) by adding at the end thereof the following new sentence: "Administrative funds may not be made available for incentives, grants, and studies for renewable energy and other small business activities.".

SEC. 9. REPORTS.

(a) REPORT BY THE SECRETARY.—One year after the date of the enactment of this Act and annually thereafter, the Secretary shall report to Congress on the programs, projects, and joint research and development ventures conducted or established under this Act and the progress being made toward accomplishing the goals and purposes set forth in this Act.

(b) NATIONAL ENERGY POLICY PLAN REPORT.—Each annual submission of the National Energy Policy Plan under section 801 of the Department of the National Energy Organization Act (42 U.S.C. 7321) shall be accompanied by a three-year strategic plan for energy technology research, development, and demonstration. Such plan shall address the role of federally assisted research, development, and demonstration in the achievement of the national policy goals of the National Energy Policy Plan and shall assess both the level of support for energy research, development, and demonstration reasonably necessary to achieve these goals and the basis for allocating the support recommended by the President among the available alternatives. At a minimum, these alternatives shall include energy efficiency and renewable energy technologies.

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II

101st CONGRESS
1st Session

S. 964

To authorize appropriations to the Department of Energy for civilian energy programs for fiscal year 1990 and fiscal year 1991, and for other purposes.

IN THE SENATE OF THE UNITED STATES

May 10 (legislative day, January 3), 1989

Mr. Ford (by request) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

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A BILL

To authorize appropriations to the Department of Energy for civilian energy programs for fiscal year 1990 and fiscal year 1991, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Civilian Energy Programs Authorization for Fiscal Years 1990 and 1991".

TITLE I—RESEARCH AND DEVELOPMENT

Sec. 101. Funds are authorized to be appropriated in accordance with section 660 of the Department of Energy Organization Act for fiscal year 1990 for civilian research and development programs of the Department of Energy for the following accounts:

(1) General Science and Research Activities, $1,169,431,000, of this amount $250,000,000 for the Federal share of the superconducting super collider project;

(2) Energy Supply Research and Development, $1,901,199,000 for all programs in this account other than programs authorized to be appropriated under section 401(3) of this Act;

(3) Geothermal Resources Development Fund, $75,000;

(4) Fossil Energy Research and Development, $163,574,000;

(5) Energy Conservation, $80,158,000 for all programs in this account other than programs authorized to be appropriated under sections 201(1) and 401(4) of this Act;

(6) Strategic Petroleum Reserve, $194,999,000; and

(7) Strategic Petroleum Reserve Petroleum Account, $126,962,000.

TITLE II—CONSERVATION, REGULATION, AND INFORMATION

Sec. 201. Funds are authorized to be appropriated in accordance with section 660 of the Department of Energy

Organization Act for fiscal year 1990 for the following appropriations accounts:

(1) Energy Conservation, $2,800,000 for appliance standards and the Federal Energy Management Program;

(2) Economic Regulation, $20,346,000;

(3) Emergency Preparedness, $6,641,000;

(4) Federal Energy Regulatory Commission, $116,550,000 of which are not more than $116,550,000 may be derived from collections of licensing fees, inspection services, and other services which may be retained and used for necessary expenses in this account; and

(5) Energy Information Administration, $65,232,000.

TITLE III—POWER MARKETING ADMINISTRATIONS

Sec. 301. Funds are authorized to be appropriated in accordance with section 660 of the Department of Energy Organization Act for fiscal year 1990 for the following appropriations accounts;

(1) Alaska Power Administration, Operations and Maintenance, $3,145,000;

(2) Southeastern Power Administration, Operation and Maintenance, $42,369,000;

(3) Southwestern Power Administration, Operation and Maintenance, $25,172,000; and

(4) Western Area Power Administration, Operation and Maintenance, $314,797,000.

TITLE IV—OTHER ACTIVITIES

SEC. 401. Funds are authorized to be appropriated in accordance with section 660 of the Department of Energy Organization Act for fiscal year 1990 for the following appropriations accounts;

(1) Uranium Supply and Enrichment Activities, $1,445,000,000;

(2) Departmental Administration, $179,923,000 together with $228,715,000 to be derived from miscellaneous revenues and receipts as necessary to provide a level of $408,638,000;

(3) Energy Supply Research and Development, $261,077,000 for the following programs in that account: international solar energy program; solar technology transfer; remedial actions and waste technology; and in-house energy management;

(4) Energy Conservation, $12,570,000 for the following programs in that account: State and local assistance programs; building and community systems; technology assessment and transfer; industrial energy conservation; implementation and deployment; multi-

sector; National Appropriate Technology and Assistance Service; and policy and management;

(5) Isotope Production and Distribution Fund, $16,243,000;

(6) Office of the Inspector General, $22,959,000; and

(7) Nuclear Waste Fund, $500,000,000.

TITLE V—FISCAL YEAR 1991 AUTHORIZATION

SEC. 501. There are authorized to be appropriated to the Department of Energy such sums as may be necessary for fiscal year 1991 to carry out civilian programs.

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OPENING STATEMENT
SENATOR JAMES A. McCLURE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
THURSDAY, JUNE 15, 1989 (9:30 A.M.)

ENERGY EFFICIENCY AND RENEWABLE ENERGY

Good morning ladies and gentlemen. Improvements in our nation's efficiency and the successful commercialization of renewable energy sources must play a critical role in our nation's long-term energy strategy. Now is the time to review and update Federal research and development policies in these critical areas.

Ever since Admiral Watkins took office as Secretary of Energy, I have been encouraged by the reviews that he has initiated to rethink, reorganize, and refocus the legacy of the Reagan Administration's energy research and development policies. Over the last eight years many of the Department's programs have become entrenched without specific goals and objectives. Other programs are now non-existent. This review is healthy.

In recent years, this Committee has demonstrated its support for these programs by conducting numerous oversight, budgetary and legislative hearings on proposals to dismantle critical research and development programs of the Department of Energy. Particular attention has been devoted to the energy security benefits to be derived by the United States from energy efficiency improvements and the development of renewable energy technologies.

Oversight hearings by the full committee and at least two subcommittees have received testimony on the status of current knowledge regarding global climate changes and, in particular the "greenhouse effect". As recently as the last recess, the full Committee held hearings in Los Angeles to receive testimony on the impact of our reliance on the automobile on global climate change, and the Mineral Resources Development and Production Subcommittee received testimony in Albuquerque on the environmental and energy benefits to be derived from greater use of alternative transportation fuels. And then only one week ago this very Subcommittee held hearings on alternative transportation fuels.

The point that I am trying to make is that this Committee has been concerned with energy conservation and the development of renewable energy sources issues since before the 1973 Arab oil embargo. Many of the initiatives that are in current law were enacted before global warming was of national concern.

More recently, various of our subcommittees and the full committee have held hearings on at least five bills -- S. 247, S. 324, S. 488 and S. 694 -- out of the numerous legislative proposals pending before the committee, which also include S. 550, S. 1031 and S. 1059, to name a few). What I am concerned about is the extensive duplication and overlay that exists among these various measures. If we continue down this path, the Committee is going to report a series of bills which overlay and, in some instances, not only are duplicative but conflict.

What is needed here is a consolidation of effort which provides the Bush Administration with new powers in the area of State energy conservation programs, energy efficiency and renewable energy research and development, and generic authority to undertake joint government and industry activities to commercialize certain new energy technologies.

In this regard, I am concerned for the extensive prescriptive detail that is set forth in many of the legislative measures that I have mentioned, and S. 488 is a case in point. I disapproved of the excessive detail contained in this bill and in similar measures during the last Congress, but I understood its political basis, which was to direct the Reagan Administration to implement programs that it was attempting to terminate. But we now have a new Administration which is prepared to work with us to formulate energy efficiency and renewable energy programs that it can support.

I am prepared to work with my colleagues to formulate such comprehensive energy efficiency and renewable energy measures. From this perspective, I look forward to hearing today's testimony and I hope this Committee will get on with this business in a reasonable, rational and comprehensive manner.

STATEMENT OF SENATOR CONRAD BURNS

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON ENERGY AND NATURAL RESOURCES

JUNE 15, 1989

Mr. Chairman, I would like to thank you for holding these hearings and want to thank our distinguished panelists for appearing hear today.

The purpose of the legislation we have before us today is to improve the competitiveness of industries that produce technology for renewable energy and energy efficiency in the United States. By establishing performance goals, multi-year funding levels and joint venture projects between the Federal government and private industry, it is hoped we can put this country's energy policy on the right track.

The section of the bill that I find to be the most workable is Section 6. Under this section, the Secretary of Energy can enter into joint ventures with the private sector to assist in the commercialization of renewable energy and energy efficiency technologies. Because of the high risks and costs associated with initial research, market-driven forces have not been a major player until the risks have been reduced. Once these risks are reduced, the private sector must be involved in commercialization. Combining public and private assistance will eventually facilitate the transition from the stage of prototype testing to commercial demonstration.

Mr. Chairman, this bill's predecessor, S.1554, was reported unanimously out of this Committee last year. I have taken a look at the report language and would like to focus this committees attention to what I believe is a very important statement. The report states that "Without the partnership between the Federal government, domestic manufacturers and marketers of renewable energy and energy efficiency technologies, and potential users that is envisaged by this legislation, the availability of these technologies to the U.S. economy could be substantially delayed. I believe this language clearly indicates the value of joint venture projects between the public and private sector.

During the course of today's hearing, I would like to learn more about these projects and, if possible, any specific ideas or proposals that have been set forth thus far. Furthermore, I believe this hearing will allow us to focus our attention upon the benefits of a close working relationship between the Administration and Congress when forming a coherent energy policy.

Mr. Chairman, I again want to thank you for your efforts and I look forward to today's testimony.

Thank you.

Senator FORD. I am very pleased the recognize the author of this legislation for his statement this morning, the Senator from Georgia, Senator Fowler.

STATEMENT OF HON. WYCHE FOWLER, JR., U.S. SENATOR FROM GEORGIA

Senator FOWLER. I thank you for those kind words and too much credit. The truth of the matter is I thank you for your encouragement, your leadership in your subcommittee, and also the majority of my former colleagues on the Energy Committee on both sides of the aisle for not only their extreme help in the development of this legislation, but their political help in the advancement of it.

I have tried in my years in both the House and the Senate to concentrate considerable efforts on conservation and renewable energy and development because I think it is in the best interest of our country, but we would not be this far without your help, Chairman Johnston's help, and the members of this committee.

That is a long way of saying I miss you.

Senator FORD. Not that much, though.

Senator FOWLER. I was forced under our rules, as you know, to give up my seat on the Energy Committee in order to go on to Appropriations. It was a very difficult choice for me.

Senator FORD. Would you like to swap?

Senator FOWLER. I always try to trade up. What I would really like is cash and two future draft choices.

Senator FORD. You have done very well in that arena.

Senator FOWLER. Thank you, my friend. Mr. Chairman, I have a prepared statement that I would asked to be submitted in its entirety in the record.

Senator FORD. Senator, it will be included in the record in its entirety.

Senator FOWLER. Since I have spoken on these issues on many occasions, both from this side of the table and from your side of the table, I think I am just going to summarize in one minute. The Administration witness is here, and there is no need to delay them by hearing from me.

The most encouraging thing about the legislation is that the Bush Administration and the Energy Department have recognized that we must not put all of our eggs in one energy basket, that the scientific evidence of the sole reliance on the fossil fuels and the burning of those fuels are causing us not only foreign policy difficulties, national security difficulties because of that dependence, but there is evidence that the problems that we are having with environment that sounded so futuristic two or three years ago, something out of Star Trek, global warming, greenhouse effects, ozone, all these things, are inextricably linked to our energy policy.

I applaud the President's strong endorsement of alternative fuels which he will be developing in his clean air package that he announced this week. I have been working with the highest officials in the Energy Department. We have a chance here to show that the taxpayers' money over the last ten years in research and development can produce commercially viable, usable alternative energy in our homes, our cars, and our places of business.

We are on track in the House, and I think that we do have the opportunity to move not swiftly because we have been working on this for almost five years. No rush. A lot of people have done a great job.

I hope after this you hear the details, especially in solar, of all sorts of new breakthroughs, and that we can get it passed out of this committee next week or after the break and get us the policy beginnings that we have needed for our country for a long time. Thank you for your leadership.

[The prepared statement of Senator Fowler follows:]

[illegible]
energy hearing

Renewable Energy and Energy Efficiency Technology Competitiveness Act
Senate Committee on Energy and Natural Resources
Senator Wyche Fowler, Jr.
June 15, 1989

Mr. Chairman, I am pleased to have the opportunity to appear before my former fellow committee members at this hearing on solar energy. As you know, I have placed a major emphasis in my public service career on conservation and renewable energy research and development. As a member of this committee, before I had to reluctantly give up my seat on Energy and Natural Resources to take one on Appropriations, I developed the legislation that is now before you as the Renewable Energy and Energy Efficiency Technology Competitiveness Act.

Since I have spoken of these issues on many occasions before this committee, I will be brief in my remarks. However, I do want to put some recent developments related to progress on the solar energy front in their proper perspective.

The most promising development is the position this administration is taking on issues that can be addressed by renewable energy technology development. The administration's broad clean air initiative is one sign of a new attitude in the White House. The new administration's position on my bill in particular, as expressed in a May 23 hearing before the House Committee on Science, Space and Technology, is an even more hopeful sign of progress in our efforts to fulfill the promise of these technologies.

When I first introduced this legislation in the 100th Congress, my efforts were spurred in part by the antagonism of the previous administration, which undid the previous consensus on strogn alternative energy programs, a consensus developed under Democratic and Republican administrations, by cutting funds for research in conservation and renewables by four-fifths. There has been a significant turnaround in President Bush's first months in office. We are now engaged in constructive negotiations with the administration on the best ways to use the resources of the federal government in developing the potential of solar and other renewable energy technologies.

This breakthrough comes at a critical time. Solar energy is beginning to make market advances. This is happening for a number of reasons: because of improved efficiency, particularly of solar and photovoltaic technology; because of a growing awareness of the low cost of running these systems once they have been established; and because the trade potential of this technology in a world starved for energy and facing environmental crisis is quickly being recognized.

Solar and photovoltaic systems also offer advantages in management of energy supply and demand. They can easily be integrated into existing utility systems, or used in remote locations not connected to a power grid. Capacity can be quickly and easily be expanded in increments that closely match demand. This flexibility offers an attractive alternative to our experience building huge power plants which, after a sometimes decades-long development process, too often turn out to be economic dinosaurs by the time they are ready to come on line.

As far as foreign oil dependence is concerned, we are now in about the same situation as we were when we started serious efforts to develop renewables during the oil shortages of the 1970s. In the 1980s, we actually increased oil consumption by a million barrels a day, even as our warships faced combat in the Persian Gulf to keep the oil lanes open.

With all these concerns, there is no doubt that the most important factor in growing acceptance of solar and other renewables is concern for the environment. The greenhouse effect, once denounced as the product of gloom and doom neurosis, is now established scientific fact. We can no longer seriously debate whether the burning of fossil fuels is damaging our environment. The public perception of the risksinvolved have taken on a new dimension with the Alaskan oil spill.

All these factors have resulted in positive movement, recognition that solar, other renewables, and energy efficiency must play an important role in an integrated, comprehensive national energy strategy. We want to encourage concepts such as cost sharing that will promote private sector involvement in developing these technologies. The shortsighted public policies did away with every incentive for this partnership. The industry is reviving, but has not nearly recognized its potential.

We cannot lose sight of the necessity of providing strong direction for these efforts. We have already learned the hard way that we cannot rely on the market by itself to make the best long-range decisions in our national interest. Market forces did not produce the best result regarding Exxon's oil spill clean up capability. They are not likely to do so in other aspects of our national energy and environmental policies -- not to mention our competitive and strategic interests.

That is the job we were elected to do. The United States must lead the way in developing energy technologies that are safe, dependable and environmentally sound. We can do this by renewing our efforts, through modest federal investments, in clean, renewable sources of energy -- conservation, biomass, wind, geothermal, as well as solar and photovoltaics.

Senator FORD. You are mighty nice, and I think that all of us agree with you that we are on the right track. We need to move forward with it, and I think we are beginning to see the crunch maybe sooner than we thought with the importation of the almost 50 percent of the oil used domestically daily. We are not capturing the resources that we have in order to prevent the deficit in trade.

This bill has so much ability to help economically and domestically. I hope that we will move fast with it, and I am very pleased with the position the administration is taking as it relates to this legislation.

We will find out those minor changes this morning, change them and get on with it.

Senator FOWLER. I am buttering them up a little bit here.

Senator FORD. We thank you for being here. If you would like to join me, I would be more than delighted to have you.

Senator FOWLER. I have to go to another committee, Mr. Chairman, but I may be back.

Senator FORD. That is understandable. If you want to come back, we would be delighted to have join us this morning. Thank you very much.

The Administration this morning will be represented by John R. Berg, who is Assistant Secretary, Conservation and Renewable Energy from the U.S. Department of Energy. Dr. Berg, we are delighted to see you this morning. If you have an opening statement that you want to submit for the record and highlight, whatever you want to do will be up to you.

STATEMENT OF DR. JOHN R. BERG, ASSISTANT SECRETARY, CONSERVATION AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY, ACCOMPANIED BY REID DETCHON, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY; AND ALAN STREB, DEPUTY ASSISTANT SECRETARY FOR CONSERVATION

Dr. BERG. Thank you, Mr. Chairman. I certainly would appreciate it if you would introduce it into the record, and if I may orally summarize, I surely would appreciate it.

Senator FORD. Your statement will be included in the record in full and we look forward to your highlighting.

Dr. BERG. Thank you very much, sir. I am accompanied today by Reid Detchon the Principal Deputy Assistant Secretary for Conservation and Renewable Energy, Mr. Alan Streb, the Deputy Assistant Secretary for Conservation.

We appreciate this opportunity to appear before you today and to provide you our perspective of S. 488, the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989. Over the past two decades conservation and renewable energy have made vital contributions to our energy security, economic health, and quality of life.

During this period, conservation has emerged as a major domestic and international resource making major in-roads into virtually every energy production and demand sector, improving the efficiency with which all fuels are used, providing a powerful impetus to expansion of a domestic economy.

Meanwhile, renewable energy has become one of the fastest growing sectors in the energy market place, increasing its share of the domestic energy supply mix by some 30 percent in the past 20 years, and now supplying nearly 10 percent of the total domestic energy production.

The research sponsored by the Federal Government and the private companies is now bearing fruit in better materials and improved components and system designs, which will increase energy use efficiency and make alternative fuels both reliable and economically attractive.

I would like to mention three most significant accomplishments during 1988. In our photovoltaic program we set four world records, two with amorphous silicon, and two multijunction cells. The United States is now the world leader in amorphous silicon thin film devices.

The Department has established three high temperature superconductivity pilot centers, one at Argonne, one at Los Alamos, and one at Oak Ridge National Laboratories. I am very pleased to say that we have at the present time signed industrial agreements with some 15 different industrial entities, and have about 29 more that are in active negotiation.

In our transportation program, the first phase in design and procurement of improved ceramic components for the automotive gas turbine has been completed through collaborative efforts with the ceramic industry. These components, when developed, will enable operation of small gas turbine engines at temperatures in excess of 2,500 degrees fahrenheit, thereby providing a potential efficiency improvement of more than 30 percent over today's technology.

Mr. Chairman, while much has been accomplished, neither conservation nor renewable energy has approached its full economical or technical potential, and properly focused federal efforts can help in sustaining and building upon past achievements and current practice.

Secretary Watkins has stated repeatedly his commitment to develop conservation and renewable energy as important components in the portfolio of energy technology which will be required to meet national, economic, energy and environmental objectives. We are moving as quickly as possible to translate that leadership into cogent and well articulated policies, programs and strategies which will form the framework within which the Department, Congress, State and local governments, and the appropriate private sector energy suppliers and consumers can all take appropriate actions to meet our responsibilities.

While the Department does not support the bill as currently drafted, we do support its intent and can support many of its provisions. The Department, in principle, supports a basic reauthorization of the conservation and renewable energy programs. We believe that S. 488 may provide an opportune and powerful vehicle to communicate to industry and the public the importance of conservation and renewable energy.

S. 488 would establish in legislation, national cost, performance, and commercial goals for some of the renewable energy technologies. The Department has developed conservation and renewable energy plans containing many of the goals identified in the legislation. We are currently in the process of updating these plans to reflect R&D advances and current competitive conditions, and to strengthen the linkage between research and development activities, future market opportunities, and the Federal, State, and private sector strategies which are required to reach these goals.

With regard to Section 4 of the bill, we would therefore recommend that the committee provide more flexibility to the Department.

Regarding Section 6 on joint research and development ventures, the Department has initiated various collaborative research mechanisms as a vehicle for effective technology transfer. We believe that many of our efforts have been productive and in many instances innovative. We are prepared to support additional ventures of the type contemplated in Section 6 and agree that cost sharing must be a primary objective in successful collaborative efforts. We believe that cost sharing for such projects should increase from 30 percent to 50 percent. This will help to win projects that have substantial private sector support. We recommend more general language directing the Department to pursue joint ventures with a basic authorization for conservation and renewable energy.

Regarding demonstration projects, we are fully aware of the interest that exists within the renewable energy industry in demonstration of technologies and skill. However, the Department does not support the requirement in Section 6(e) for three demonstration projects. The cost effectiveness for demonstrations, particularly at a time of intense budgetary pressures as compared to the payoff in research and technology development is questionable.

I would like to point out that the Department would be willing to reevaluate its policy concerning the proper scope of their potential participation along the technology development continuum as part of the internal reviews currently underway.

With regard to renewable energy exports, the Department recognizes the importance of international market opportunities to the renewable energy technologies. We believe that the activities funded within the international line item are worthy of support. The Department of Commerce trade promotion activities and activities in support of CORECT, have been productive to date and show that the public and private sector can effectively collaborate in exploiting foreign trade opportunities. We think that the requirements of S. 488 to establish a public-private master plan for market share should more properly emphasize the level of exports since market share can be affected by a variety of uncontrollable circumstances.

Finally, we recommend that the committee consider modifying or eliminating the requirement of Section 9 for a separate three-year strategic plan for energy technology. We think that the committee will be pleased with the degree that strategic considerations are incorporated in future iterations of technology plans, and the integrated national energy strategy as reflected by the National Energy Policy Plan.

With the spirit of cooperative and shared objectives I believe we can work together to shape specific language which we mutually support.

Mr. Chairman, we want to work with the committee to achieve that objective. We appreciate the opportunity to appear before you today and to gain your advice on these matters. I would be happy to answer any questions which you or the subcommittee may have in these matters.

[The prepared statement of Dr. Berg follows:]

STATEMENT OF

DR. JOHN R. BERG

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY

U.S. DEPARTMENT OF ENERGY

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

U. S. SENATE

JUNE 15, 1989

Mr. Chairman and Distinguished Members of the Committee:

Thank you for the opportunity to appear before you today to share our perspectives with the Committee concerning S. 488, the "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989."

Energy efficiency and renewable energy are critical elements of our national energy resource. Secretary Watkins, in his first months in office, has stated repeatedly his commitment to developing conservation and renewable energy as important components in the portfolio of energy technology which will be required to meet national economic, energy, and environmental objectives. We are moving as quickly as possible to translate that leadership into cogent and well articulated policies, programs, and strategies which will form the framework within which the Department, the Congress, State and local governments, and individual energy suppliers and consumers can all take appropriate action to meet our respective responsibilities.

The availability, cost, security, reliability, safety, and environmental impact of energy supply and use are fundamental to the strategic interests of the Nation. They affect our competitiveness, productivity, national security, and environmental quality.
If we develop the technologies necessary to explore, capture, and exploit all of our domestic resources economically and with minimal damage to the environment, we can provide the energy we need for economic growth in the forseeable future.

Over the past two decades, conservation and renewable energy have made vital contributions to our energy security, economic health, and quality of life. During this period conservation has emerged as a major domestic and international resource, making major inroads into virtually every energy production and demand sector, improving the efficiency with which all fuels are used, and providing powerful impetus to expansion of the domestic economy. Since the energy crises in the early seventies, the Nation has made great progress in reducing the amount of energy we use to produce a dollar of gross national product (GNP). GNP has grown about 40 percent while energy consumption has remained relatively constant.

Meanwhile, renewable energy has become one of the fastest growing sectors in the energy marketplace, increasing its share of the domestic energy supply mix by some 30 percent in the past 20 years, and now supplying nearly 10 percent of current total domestic production. Equally important, the private sector has made significant strides in introducing new high technology products into commercial use. However, neither conservation nor renewable energy has approached its full economic or technical potential, and properly focused Federal efforts can help in sustaining and building upon past achievements and current practice.

The Department and the Committee have long discussed many of these subjects, and I believe we are in general agreement on them.

Beginning with today's hearing, we hope to move toward consensus in several additional areas through mutually supportable legislation based on S. 488. While the Department does not support the bill as currently drafted, we do support its intent and can support many of its provisions. I would like at this time to share our perspectives on the specific provisions of the bill and offer some recommendations which we hope will lead to legislation acceptable to the Committee, the Department, and the conservation and renewable energy community.

The Department in principle supports a basic reauthorization of the conservation and renewable energy programs. We believe that S. 488 may provide an opportune and powerful vehicle to communicate to industry and the public the importance of conservation and renewable energy; to reaffirm national commitment to sustaining the R&D necessary to realize their vast potential; to establish a multi-year funding and research strategy, to increase the participation of the private sector, both to facilitate technology transfer and to ensure that public funds are, in appropriate measure, focused on areas where the private sector believes that the greatest opportunities lie; and to authorize the Committee on Renewable Energy Commerce and Trade (CORECT) to pursue foreign market opportunities for renewable energy products and services to be provided by domestic firms. With a spirit of cooperation and shared objectives, I believe we can work together to shape specific language which will be mutually supportable.

S. 488 would establish, in legislation, national cost, performance, and commercial goals for some of the renewable energy technologies. The Department has developed conservation and renewable energy plans containing many of the goals identified in the legislation. We are currently in the process of updating these plans to reflect R&D advances and current competitive conditions, and to strengthen the linkage between R&D activities, future market opportunities, and the Federal, State and private sector strategies required to reach these goals. We expect to cooperate with other Departmental elements to ensure that technology plans across the Department employ consistent economic and policy assumptions and that they serve as building blocks for an integrated national energy strategy.

With regard to Section 4 of the bill, we would therefore recommend that the Committee provide more flexibility to the Department. We share the view that technology plans should be developed with an appreciation for their marketplace significance; we recognize the importance of private sector participation; and we agree that the Department should continue to periodically transmit plans, or their updates, to the relevant Committees of Congress. Legislated cost and performance goals, on the other hand, would not allow us to adjust to changing conditions and markets. The Department had experience with National goals during the energy crisis of the 1970s. For example, by 1992 we were supposed to produce 2 million barrels of crude oil per day of synthetic fuel. It will not happen because markets and events moved in a different direction. That is why we must provide flexibility to create a partnership with the private sector rather than legislating goals that cannot adjust to the changing market. In particular, the Department recommends that the Committee reevaluate the inclusion of market penetration targets within the legislation. Our past experience with such legislated goals indicates that they are soon outdated, that they often create rather than resolve uncertainty within the private sector, and that they are so dependent on factors outside the control of either the Department or industry that they do not provide a reasonable basis for program planning or accountability.

As stated earlier, the Department supports a basic re-authorization for the conservation and renewable energy programs. The Department also supports multi-year authorizations and has initiated a process to internally evaluate all energy programs, priorities, and strategies. The Department is also attempting to improve its multi-year programming and budgeting of resources. We are not today prepared to support the specific authorizations proposed in this bill. We are, however, prepared to commit to working together with the Committee as our internal initiatives yield results to shape a mutually supportable set of multi-year program authorizations. I am persuaded that with a continuing dialogue we can expect to arrive at mutually supportable time-frames and levels of authorization.

With regard to Section 6, concerning joint R&D ventures, the Department has initiated various collaborative research mechanisms as a vehicle for effective technology transfer. We believe that many of our efforts have been productive and in many instances innovative. We are prepared to support additional ventures of the type contemplated within Section 6 of the bill, and agree that cost sharing must be a primary objective in successful collaborative efforts. However, the specificity of the legislative language would add an undesirable and unnecessary rigidity to the process. We recommend more general language directing the Department to pursue joint ventures within a basic authorization for conservation and renewable energy.

The Department is fully aware of the interest that exists within the renewable energy industry and the Committee in seeking out common ground regarding development of technologies at scale. However, the Department does not support the requirements set forth in Section 6(e) that DOE specify in its FY 92 budget request three demonstration projects in sufficient detail to support the solicitation of bids. The cost-effectiveness of demonstrations, particularly at a time of intense budgetary pressures, as compared to the payoff from research and technology development is questionable. In general, commercialization activities such as large scale demonstration programs are most appropriately undertaken by the private sector, which is in the best position to assess the marketability of new technologies. Industry's willingness to invest in a new technology is frequently the best indicator of its near term market potential. In addition, demonstration programs frequently require a disproportionate share of a very limited Federal budget, which could be better used to conduct higher risk research and technology development that might not otherwise be performed by industry. The Department will be reevaluating its policy concerning the proper scope of potential participation along the technology development continuum as part of the internal reviews currently underway. I should also note that considerable funds and staff resources would be required to comply with the Committee's direction as drafted. Diversion of such resources would constrain an already stringent research program and could prove counterproductive.

With regard to Section 7, concerning renewable energy exports, the Department recognizes the importance of international market opportunities to the renewable energy technologies. The Department believes that the activities funded within the International line item are worthy of support. The Department of Commerce trade promotion activities, and activities in support of CORECT, have been productive to date and show that the public and private sector can effectively collaborate in exploiting foreign trade opportunities. However, the requirement in S. 488 to establish a public-private master plan for market share should more properly emphasize the level of exports since market share can be affected by a variety of uncontrollable circumstances. The Department would prefer to work with the Committee to shape a mutually supportable basic reauthorization of CORECT; to encourage the use of Federal, private, and laboratory expertise as design or technical assistance to exploit targeted market opportunities; and to simplify administrative procedures for exports.

With regard to Section 8, the Department agrees that timely and accurate communication of program results and lessons learned on the benefits of conservation and renewable energy can provide valuable assistance to Federal agencies, while providing market opportunities for competitive renewable and energy efficiency technologies. We look forward to continuing to work with the Committee to reach agreement on specific language in this area.

Finally, in keeping with my earlier remarks concerning the planning process currently being shaped within the Office of the Secretary, we recommend that the Committee consider modifying or eliminating the requirement in Section 9 for a separate three-year strategic plan for energy technology. We believe that the Committee will be pleased with the degree that strategic considerations are incorporated in future iterations of technology plans and the integrated national energy strategy, as reflected by the National Energy Policy Plan.

In conclusion, I wish to assure the Committee that the Department fully appreciates the strategic value of conservation and renewable energy, and, while we cannot support the bill as drafted, we believe that further discussions could lead to mutually supported legislation. We want to work with the Committee to achieve that objective.

Mr. Chairman, this concludes my prepared remarks. I appreciate the opportunity to appear here today, and I am prepared to address your questions at this time.

Senator FORD. Dr. Berg, it is obvious that other things are going on this morning, and some pretty heavy legislation is going to be brought up this afternoon. Apparently some of the meetings are being held this morning, some starting at 10:00 a.m.

I have one request rather than a question. It appears that the administration and this bill, S. 488, are not too far apart. You have some requests. I would like to request you and your people to provide us with a markup copy, if you would, of the Fowler bill showing the changes that you would like us here in the committee to make to the bill and the reasons for the change.

If you could do that, I think we could move very quickly with an accommodation, I think, after listening to your statement, of where you want us to go, and we could move this bill fairly well.

Do you know what is happening to the bill in the House? It is being marked up this morning, as I understand it.

Dr. BERG. As I understand it, markup is occurring at the present time. In fact, we have people over there at this time.

Senator FORD. Are they making the necessary changes that will accommodate the administration, do you know?

Dr. BERG. They are more than meeting us halfway in these accommodations, yes, sir.

Senator FORD. Fine. It seems like it is something where we can put a little Henry Clay on it, the great compromise.

If you would do that for us, then we would have that to peruse prior to the markup here, and I think it would put us a giant step ahead of where we might be when we get into whether or not you are for it.

Could you do that for us?

Dr. BERG. We will do that, sir.

Senator FORD. That would just be great. I have no further questions, Mr. Berg. I appreciate your coming this morning as well as your two colleagues. I know you get pulled and pushed, and you run from one building to another. Maybe we will not treat you too unkindly this morning.

Dr. BERG. Thank you very much, sir.

Senator FORD. Thank you, Dr. Berg. I appreciate it.

The next witness will be a panel of witnesses: Mr. James Wolf, Executive Director, Alliance to Save Energy; Mr. Scott Sklar, Executive Director, Solar Energy Industries; and Mr. Dan Seligman, Assistant Legislative Director of American Wind Energy Association.

So we will start with Mr. Sklar and move to his left.

STATEMENT OF SCOTT SKLAR, EXECUTIVE DIRECTOR, SOLAR ENERGY INDUSTRIES ASSOCIATION

Mr. SKLAR. Thank you, Senator.

The Solar Energy Industries Association is a national trade association for both the photovoltaic and solar thermal manufacturers and component suppliers. Obviously we are elated about and strongly support S. 488. We believe the legislation encourages greater industry and government cooperation, encourages joint ventures and refocuses the program from a long-term, high risk R&D program to maintaining some pure R&D but making sure it reaches the marketplace.

Our industries are facing intense international competition. Over 65 percent of our technology is exported mostly to the third world who desperately need renewable energy technology.

The issues that we need to be developed here and which we need you to be aware of is:

One, that photovoltaics has now achieved 20 world class records in 1988, the top one being a 31 percent efficiency breakthrough in photovoltaics. We have a 25 percent increase in sales. We are fighting the Japanese in the marketplace. Our budget is $35 million. Japan's budget for photovoltaics is $48 million. Germany's budget for photovoltaics is $68 million. So in terms of Federal support, it is much higher than ours.

In addition, they get concessionary financing at 2 percent.

In addition, they have tax credits in both of those countries.

In addition, they high tight aid programs which essentially give interest-free loans to third world countries to buy our products.

So whereas we lead technologically—and we do. We are still holding on—the chance that we may lose in the marketplace is very high unless we get innovative.

The next technology is solar steam where we convert sunlight to steam to electricity. We have 200 megawatts in California privately financed. It came out of the 1970s R&D program. We have 400 megawatts coming on line within the next year and a half, also privately financed. We have 200 megawatt signed contracts after that coming on line and outside of California.

So what we are seeing is that the technology is winding up in the utility sector because they desperately need clean electricity at noontime. That is when sunlight works.

We have a new series, a new generation of concentrating technologies that use dishes and engines which came again out of the space program like photovoltaics where you can concentrate sunlight on an external combustion engine and turn an electrical generator.

That technology will enter the marketplace in 1991, and it will not just be tied to the southwest. This technology will be able to be used throughout the United States for peak power.

The third kind of technology and concentration that we have been working on is that we have had some massive breakthroughs in breaking down toxic waste using solar concentration, and it is not the heat that breaks down the waste. It is indeed that the sunlight creates a different chemical reaction, and we have had successful field tests with EPA observers breaking down dioxins, paint solvents and a whole range of other kinds of chemicals that EPA has been trying to deal with with no hazardous byproducts.

So we have been looking to make sure that this technology, which is a side technology out of the program but could provide a high value market for our industry be allowed.

Senator Ford. Could I ask you a question. What do you mean when you say break down?

Mr. Sklar. By running, let us say, a liquid solution of water containing dioxin in front of a reflector, in 15 seconds the bonds are broken. What happens when the bonds are broken is a unique chemical reaction where you get the carbons being pulled out in one direction and the rest turning to table salt after it is run over a catalyst.

That is really it. You wind up with two products, a carbon product and a table salt product. They are both very benign.

Senator FORD. What do you do with the carbon?

Mr. SKLAR. It is essentially a charcoal, and you can use it for filtration process or something else.

Senator FORD. And the salt?

Mr. SKLAR. The salt is table salt. You can use it for anything. Some industries use it.

The fact of the matter is what helps us with many small industries that are having problems who have three barrels a month of waste and are not going to build a $2 million incinerator, we may have a market where we can either sell them these very small concentrators or develop essentially cooperatives of businesses where we can just break down those wastes a few barrels at a time a couple of times a year, and we do not have these storage problems.

The last technology, solar water heating and passive solar, we have made some great breakthroughs in window films, increasing the insulating factors of windows from our one to now at the Solar Energy Research Institute about 11 and could have profound impacts in terms of saving energy both for cooling and heating.

We have a million solar hot water systems in the United States. That sounds large. The City of Tokyo alone has a million solar hot water systems.

To show you something, the Southern California Air Quality Board in determining some draconian measures to clean up air in Southern California has gotten a lot of press. They have come to the conclusion that after carpooling, the cheapest way to remove ozone and CO_2 out of the air is solar water heating. The residential sector is one of the biggest polluting sectors, and we need to deal with that problem.

There have been some real advances. This bill helps all these technologies and other renewables to build a base, to increase research and really become competitive.

I want to comment on the administration's review of the bill. They have come a long way in trying to meet us halfway. I would like to comment on where we agree and where we do not.

We agree that there ought to be just two advisory committees, one for conservation and one for renewables. It makes sense.

We agree that the joint venture language could be tweaked to joint agreements to give them some flexibility.

We do not agree that the demonstration projects are not worth pursuing. There are two kinds of technologies: one where you really just need a joint venture to get it to the marketplace to commercialize; the other is they are larger in scale or slightly new technology, and you need to give the utility industry a chance to touch and feel and experiment with it before they will commercialize.

We work with three very conservative industries: the utility sector; the building sector; and the financial sector, so it takes a while to build confidence with new technology.

We can live with the requests for changes in the export side, but we cannot live with their idea on the cost shares on joint ventures which we think is very shortsighted. 85 percent of this industry is small business. Most of the innovation is coming out of small business. What we have requested the House to do is say yes. We could increase this to a 50/50 cost share, but there needs to maintain this 30 percent cost share for small business.

If you increase the cost share to 50 percent, you will have 20 companies that can take advantage, and 85 percent of the rest of this industry will not take advantage. So we hope that there can be a small business waiver in this to make sure that our industry can utilize this legislation.

The final concern is this three-year plan. We agree that the language needs to be changed slightly but not so that they just have to deal with solar and renewable energy and conservation and the national energy policy plan. They have done that forever, and it has not changed a thing.

What they need is a three-year strategy plan on how to commercialize solar and renewable energy before our international competitors.

My closing comment, Senator, we have put millions of dollars for the United States to commercialize this technology. We lead in almost all these areas—in solar, wind, biomass—ahead of our competitors. If we do not get our act together, we may be importing all this solar and renewable energy technology when the year 2000 comes around, and that would be a shame.

Thank you very much.

[The prepared statement of Mr. Sklar follows:]

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TESTIMONY

by

SCOTT SKLAR
EXECUTIVE DIRECTOR
SOLAR ENERGY INDUSTRIES ASSOCIATION

before

SENATE ENERGY & NATURAL RESOURCES COMMITTEE
SUBCOMMITTEE ON ENERGY RESEARCH & DEVELOPMENT

on

RENEWABLE ENERGY & ENERGY EFFICIENCY TECHNOLOGY COMPETITIVENESS ACT OF 1989 (S.488)
CIVILIAN ENERGY PROGRAMS AUTHORIZATION FOR FISCAL YEARS 1990 AND 1991 (S.964)

JUNE 15, 1989
WASHINGTON, D.C.

INTRODUCTION

The Solar Energy Industries Association (SEIA), the national trade organization of the photovoltaics and solar thermal manufacturers and component suppliers, strongly endorses, H.R. S.488, the "Renewable Energy & Energy Efficiency Technology Competitiveness Act of 1989". The legislation provides urgently needed direction and stability of the United States solar and renewable energy research and development efforts. SEIA also supports, in part, S.964, the "Civilian Energy Programs Authorization for Fiscal Years 1990 and 1991".

While U.S. energy policy has generally ignored solar energy development, our international competitors sensing a vacuum have steadily increased their solar energy research, development, and export assistance programs. And while the United States was the acknowldged leader of all solar technologies in the 1970's, we are gradually losing our technical edge due to an era of indifference and lack of foresight. Federal funding for solar programs dropped precipitously over the last eight years. Photovoltaics funded in FY'81 at $155 million by FY'89 reached $35.5 million and in FY'90 OMB requested a cut in photovoltaics research by 30 percent to $25.0 million. The Administration has also proposed a 15 percent cut in the solar thermal power research budget which was funded at $121 million in FY'81 and cut to $15 million in FY'89 with an Administration request for $13.0 million in FY'90. A 20 percent cut in solar buildings is requested for solar buildings research funded at $77 million in FY'81 and cut to $5.4 million in FY'89 with a recommended cut to $4.2 million in FY'90.

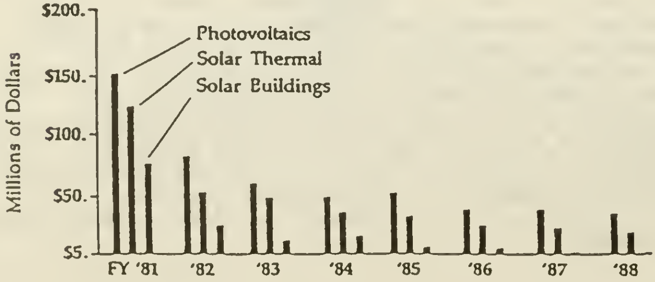
The proposed legislation S.488 enhances the programs, encourages greater industry/government cooperation, and establishes long term goals essential to refocus the federal solar programs to maintain our worldwide technical leadership. These initiatives must pass before it is too late and our industry is bypassed by the more ambitious efforts of our international competitors.

How ironic would it be for the United States to have to import the very technologies we developed and created. The legislation is the only answer to prevent VCR Syndrome, where the U.S. has spent hundreds of millions of dollars to develop solar technologies that are commercialized by our international competitors who will reap billions of dollars and millions of jobs. Our country needs to position itself in the 21st century as a technological leader in technologies that are renewable, increase world productivity, and deter glocal climate change.

The years of 1989/1990 will determine whether the United States will have a domestic solar energy industry or relinquish its technological leadership to our international competitors. Our country faces the real possibility of importing solar technologies in the years when they become fully cost-competitive. From my point-of-view, the United States lacks an effective energy policy and has biased priorities against maintaining our technical predominance and development of solar and renewable energy technologies. This bias is exemplified by the Administration's request to cut the $352 civilian nuclear energy research budget by only $2 million in FY'90 in contrast to their request to cut the aggregated solar budgets of $56.9 million by $13.2 million.

At some point, the U.S. Congress must come to terms as to whether you want to maintain a United States solar energy research effort. The U.S. Congress must also come to terms that at some level, lower solar budgets will not be effective in furthering the technology. The Solar Energy Industries Association, the national trade organization of the photovoltaic and solar thermal manufacturers & component suppliers, believes that the FY'89 funding levels are that bottom line. Therefore, the U.S. solar energy industry asks this Committee to hold the line, maintain an effective U.S. solar energy effort, and come to grips with the reality that if the United States does not push the technology out of the research pipeline, our international competitors will, and the United States will be totally reliant on our competitors for solar technologies for generations to come. Congressional actions in these two years will determine the outcome since the Administration has shown a "business as usual" approach.

Trends in Federal Solar R&D FY '81 - FY '88



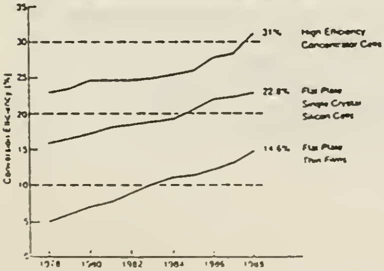
PHOTOVOLTAICS

The United States photovoltaics program has three basic thrusts: Bring down the costs of the technology through increased efficiency through the development of new materials and processes in manufacturing photovoltaic cells; Assist the industry in cost-shared research to commercialize research developments; and provide design assistance & review for large-scale photovoltaic systems for export, and government & utility procurement.

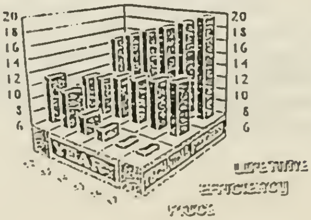
As you can see in the addenda, the photovoltiacs program has made great strides with over twenty world efficiency records of photovoltaic cells and modules. The chart below summarizes the cost reductions and the increases in lifetime & efficiency over the last six years as a result of the research program. The United States has maintained our technological lead worldwide due directly these research efforts. However, while the U.S. photovoltaic marketshare has been maintained through level funding during the FY'88-89 years, the precipitous cuts recommended by the White House (30%) will undercut the U.S. industry so badly that it is very unlikely the industry would ever recover. I cannot emphasize enough to this Subcommittee, that whatever the Congress decides has profound effect on the private investment markets. When Congress maintained level photovoltaic research monies in FY'89, increased private capital flowed to our industry. If Congress cuts this small research program, the private markets will sense that the United States government lacks the resolve to commercialize photovoltaic technology, and disinvestment will occur. Program cuts will insure that the United States will lose both our technological and market leads to both Germany and Japan.

The U.S. Department of Energy Photovoltaic Program has been effectively managed, and has developed an excellent relationship with the private sector. The national laboratory and university efforts are effectively integrated into the research program. This R&D program is a model on how best to commercialize high-technology. Funding for FY'90 should be increased to $40 million or at least maintained at the current $35.5 million level.

Progress in Efficiencies for Laboratory Cells



PV POWER MODULE STATUS



SOLAR BUILDINGS

The U.S. Department of Energy Solar Buildings Program is the smallest of the research and development programs and has been essentially at a closedown level of $5.4 million over the last few years. While buildings consume nearly 35 percent of U.S. energy and produce more greenhouse gases than the U.S. utility sector, this energy research area receives the least support. While the United States sits idly by, our international competitors in Scandanavia and Japan have geared up to commercialize energy efficiency technologies which have already begun to enter the United States market.

The solar building research effort has centered on three basic research areas: Solar cooling research using desiccant cooling technologies and new polymers in desiccants which can absorb up to 2000 percent of their own weight, efficiently dehumidify air thus providing cost-effective space cooling. The result of this research will save consumers millions of dollars for space cooling as well as saving utilities from building costly power plants to meet daytime cooling demands.

The second research area focusses on both passive and active solar design assistance. The Solar Energy Research Institute has worked with industry to develop a computerized energy simulation program for seven building types in two climate zones. This computer program will help builders select cost-effective passive solar applications in our nation's buildings. Under US/DOE auspices, SEIA and ASHRAE have developed a commercial-scale solar water heating design manual based on our experience over a decade with solar systems on federal and commercial buildings. In 1989, SEIA/DOE will develop and publish companion installation and operations/maintainance manuals for these large-scale systems. The final program thrust involves research on electrochromic or "smart" windows. By deposing an transparant metal-oxide material on glass, cooling costs for both buildings and automobiles may be significantly lowered. This technology along with photochromic glass has useful potential in the active solar industry in making collector glazings more efficient.

The potential markets for energy efficient technologies are extraordinary. But again, if the United States does not have the interest to commercialize these technologies, our competitors will. Does the United States have the resolve to follow-through on its research? Only the U.S. Congress can answer this question.

SOLAR THERMAL POWER

The United States now has 200 megawatts of completely private sector financed solar-steam-to-electricity utility-grade power plants. The solar trough concentrators used derive directly from US/DOE-sponsored research. This glass technology will soon be superceded by US/DOE developed stretched membrane technology utilizing a silver-coated polymer. The polymers will reduce the cost of this technology even further. Utilities are utilizing solar thermal technology for peak-power applications because they produce the most power during the utility's greatest demand for electricity (noontime), and they have minimal regulatory obstacles due to their cleanliness (no polluting emissions) and surety of supply (sunlight) that they can be constructed within fifteen months.

The U.S. Department of Energy Solar Thermal Power Program has three major program thrusts. First, the program will finish the upgrading of stretched membrane dishes and heliostats to efficiently concentrate sunlight. Actual trial tests are necessary to assess research progress and permit fine tuning. Secondly, second generation work to develop working solar dish concentrators which focus sunlight on engines that are capable of running electric generators, is being pursued through industry joint ventures. Finally, technology spin-offs to power lasers and detoxify wastes will be aggresively pursued as a new cost-effective high value market for these technologies.

The solar thermal technologies are also being commercialized by our industrial competitors. The European Consortium, Phoebus, plans to build a 30 megawatt solar central receiver tower in Jordon using stretched membrane heliostats. Such a venture by European governments may thrust European industries as the major commercializers worldwide of this technology.

The Solar Thermal Power Program should be funded at the $20 million level in FY'90 to remain competitive. A minimum of $17.5 million is necessary just to maintain ongoing programs. Cuts to $13 million as proposed by the Administration would effectively cut out the U.S. industry from federal research efforts and just support limited laboratory work that may never be commercialized. Price breakthroughs, so far, have been very promising as shown in the charts in the addenda taken from the August 1988 Report to Congress titled, "Bringing Solar Thermal Technology to the Marketplace".

Solar thermal power technologies have shown that they are competitive in the peak power utility markets today. New advances in technology will make them even more competitive. The world markets offer a virtually unlimited opportunity to successfully commercialize these technologies. Solar thermal power offers a competitive way not only to produce electric power but detoxify hazardous wastes, accomplished successfully by Sandia National Laboratories in 1988. Successfull experiments by the Solar Energy Research Institute in 1988 which concentrated sunlight 60,000 times, enough to power lasers, is a breakthrough important to pursue.

The Solar Thermal Power Program has an effective working relationship between the primary national laboratories, the Solar Energy Research Institute (SERI), Sandia National Laboratories, and the U.S. solar thermal industry. The research program deserves higher consideration by the Congress as an important element of federal research.

INTERNATIONAL

The international line item of the U.S. Department of Energy supports multiagency activities mandated under P.L. 97-370 which created the federal interagency board, The Committee on Renewable Energy Commerce and Trade (CORECT) to coordinate federal efforts to promote solar & renewable energy exports. This small $1 million program leverages more money than any renewable energy program in the U.S. Department of Energy Conservation & Renewable Energy program.

Aside from a series of trade missions and education materials, the program is supporting a conference and trade show in May 1989 to promote U.S. renewable energy technology & services in the Caribbean Basin & Latin America. The program coordinated by the U.S. renewable energy trade association umbrella group, the U.S. Export Council for Renewable Energy (US/ECRE), is the first of a series of market sector promotion program geared to meet increasing international competition from our international competitors.

The $1 million program should be increased to $2.5 million rather than cut to $0.5 million as recommended by the Administration. For the last eight years, the United States renewable energy effort was focussed, wrongly, on long-term, high risk, research & development. This small program is the only short term government effort to meet our competition head-on. The international program ought to be preserved and enhanced.

CONCLUSION

The United States solar energy research and development program has been an outstanding success even through disinterest, budget cuts, and low energy prices. Solar water heating technologies are fully integrated into the marketplace with some utilities instituting incentive programs for peak load shaving. Over 200 megawatts of solar thermal power technologies provide utility-grade electricity for over 150,000 homes with new generations of technology that will be lower cost. Photovoltaic costs have come down ten fold in a decade and the program has had over twenty efficiency records in 1988 alone! As research increases, solar energy costs will be lowered and market penetration will significantly increase.

Solar energy technologies can reduce greenhouse gas emissions significantly by over 30 percent in the building sector which which accounts for 35 percent of our energy, by over 20 percent in the utility sectory for peak power and in some instances baseload generation which account for 25 percent of our energy, and for remote power applications which account for 5 percent of U.S. energy use and over 50 percent of Third World energy use.

The authorizations in S.488 are appropriate in that they turn support around to redevelop our national solar energy effort. Multiyear authorizations are absolutely essential for industry to plan and add stability for program development and planning. In addition increases in funding will in turn add confidence to the private capital markets attracting further investment in the U.S. solar energy industries. While the goals are more ambitious than the funding levels, it is important that the bill be pragmatic to insure passage, and I urge the Subcommittee to stick with the numbers and push for passage in 1989. I caution the Subcommittee that failure to do so will cause an irreversable chain of events that will cause private investment to dissipate and foreign competitors to control the world markets and ultimately our own.

Joint ventures are an essential component to this legislation and have been shown as effective by our international competitors particularly in Germany and Japan. However, the Congress must be aware that the U.S. solar energy industry is a very young and small industry. The vast majority of solar companies are less than fifteen years old and are small businesses. Therefore, industry contributions should not only include financial contributions but in-kind contributions in land, labor, licensing and comparable investments.

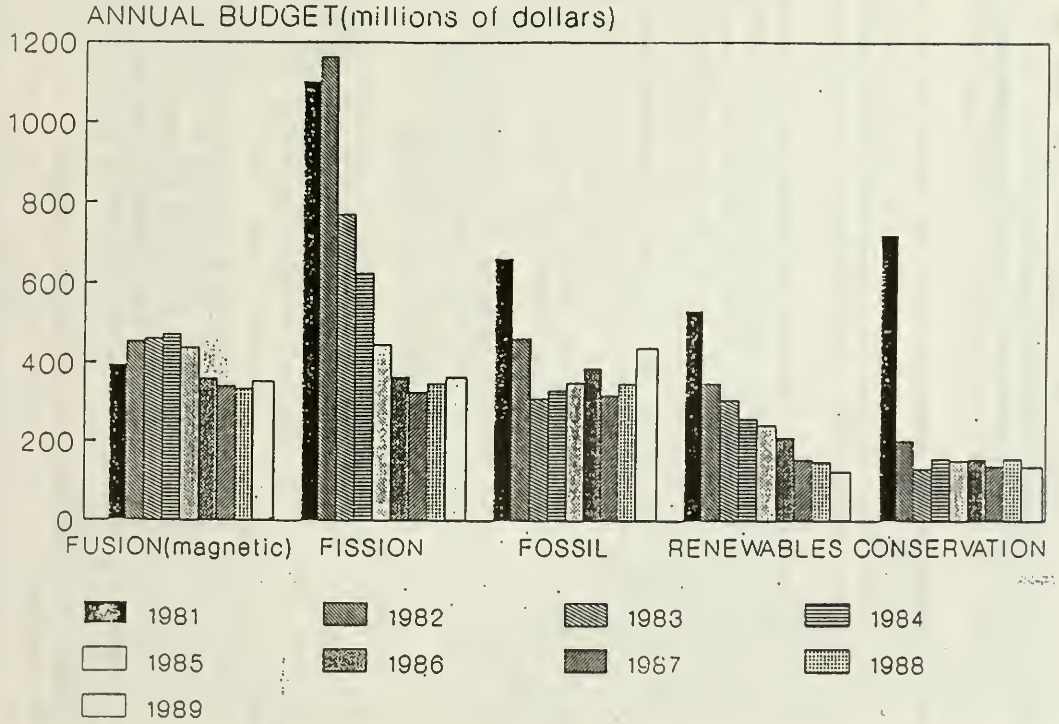
Solar joint ventures and agreements are applicable in manufacturing passive solar and solar water heating equipment and products, photovoltaic manufacturing and project development, and solar thermal power utility and industrial process heat applications and projects. The federal government as a partner, facilitator and promotor is critical if our industries are to compete internationally. However such joint agreements should be industry-generated and not government-generated or controlled. Joint manufacturing and research projects are best initiated by the U.S. industry, especially by those companies solely dedicated to solar energy development.

The S.964 recommendations for continued funding for the National Appropriate Technology Assistance Service (NATAS) is important to transfer technical information effectively to the American public. Also under Title IV, the building and community systems programs should be broadened to include active and passive solar applications. Under Title II, the Energy Information Administration should be required to report solar and renewable energy installations as they do for conventional energy resources.

The Solar Energy Industries Association (SEIA) commends the Subcommittee for its leadership in the continued development of solar energy research and commercialization. The Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989 (S.488) is sound public policy in the nick of time. The legislation deserves bipartisan support and quick passage. For our industries' sake and that of our country's and the world's energy, economic, employment and environmental security -- solar energy must be developed expeditiously.

How ironic would it be for the United States to import the very technologies we developed and created. The legislation is the only answer to prevent "VCR Syndrome" where the United States has spent hundreds of millions of dollars to develop solar technologies that may be commercialized by our competitors who will reap bllions of dollars and millions of jobs. Our country needs to position itself in the 21st century as a technological leader in technologies that are renewable, increase world productivity, and deter global climate change.

ANNUAL APPROPRIATIONS OF DOE CIVILIAN R&D PROGRAMS (current dollars)



Senator FORD. Senator Bumpers is here now, and he will be taking over, but let me ask just one question.

What about a 50 percent share? I am talking about if we hang up on that and only 25 percent would be cash and 25 percent would be in kind.

Mr. SKLAR. It really depends on the size of the project and what the joint venture is.

Again, I sat down with the House staff, and I have talked to the administration representatives here. In many cases that would be okay, but I'll——

Senator FORD. It would increase your percentage? Where you had 15 percent would take advantage of the 50/50, 85 percent? That would increase that 15 percent to something bigger?

Mr. SKLAR. I still believe you ought to give the Department of Energy the greatest amount of discretion. My view is the principle should be 50/50 cost share. But if a small business comes up that has a good idea and that 30 percent fits it and would help commercialize technology—and part of that still has to be cash. We still believe that every industry ought to put money down, but the fact is on some of these small businesses they just do not have the wherewithal.

We are cash poor industry because we are young. We are 15 years old, and business has not been great with low oil prices and the international competition beating the hell out of us.

Senator FORD. That is not going to last too long.

Mr. SKLAR. No, I hope not.

So we hope that you can provide maximum flexibility, and I expect that the Department of Energy will go along with it.

Senator FORD. I am just saying that this reduces the cash to 25 percent.

Mr. SKLAR. That helps.

Senator FORD. That helps some, and you put 25 percent in kind. You can do a lot of things with in kind support.

Mr. SKLAR. What our industry will do is provide your staff and the committee and Mr. Bumpers on the Small Business Committee with some information on how this might be tweaked a little to help small business.

Senator FORD. Mighty fine. We want to do that.

Mr. Seligman.

STATEMENT OF DAN SELIGMAN, ASSISTANT LEGISLATIVE DIRECTOR, AMERICAN WIND ENERGY ASSOCIATION

Mr. SELIGMAN. Thank you, Mr. Chairman. I represent the American Wind Energy Association, a trade organization composed of about 150 companies, including wind turbine manufacturers, component suppliers, electric utilities and wind farm developers who are in the business of generating electricity from the wind.

The American Wind Energy Association strongly endorses S. 488 and urges the subcommittee to approve this legislation. I have submitted testimony that describes the position of our association in more detail. What I would like to do today is to share with you the basic concerns of our industry, what is at stake, and why S. 488 is so important to our members.

There are now 16,000 commercial wind turbines in the United States with an installed capacity of about 1,500 megawatts. Last year we generated about 1.8 billion kilowatt hours of electricity, a sum sufficient to meet the annual residential needs of Washington, D.C.

In short, our industry has grown significantly in the last seven or eight years, and we have the potential of growing more and contributing more to our nation's energy supply.

There are excellent but undeveloped wind resources in the panhandle of Oklahoma and Texas, in western Montana, in Wyoming, and on the mountain ridges of the East Coast. Our industry wants to ensure that when those areas are ready for development it is U.S. equipment and U.S. technology that is installed there. It would be no small irony for the United States to embark on the construction of new wind farms to diversify its energy supply, to reduce oil imports, and to mitigate air pollution problems only to find that we were importing Japanese, Danish or German equipment to accomplish these goals.

In short, the key issues as we see them relate to international competitiveness and to jobs. Our competitors abroad are not standing still. Many nations in New York, for example, are now undertaking ambitious research and development activities in wind technology and new companies, many of them with backing from their governments, are entering the marketplace.

Meanwhile, the United States, which took the lead in developing wind turbine technology in the 1980s, is in danger of losing its competitive advantage. If that happens we will see dollars and jobs go overseas. S. 488 helps avoid this scenario.

In particular, the joint venture provisions of S. 488 are of particular interest to our trade association because our members would be eligible to bid for a joint venture project with the Department of Energy and work more closely with the national laboratories in developing a new generation of wind turbine technology.

For example, the joint venture R&D project for wind would allow the Department and private firms to undertake the design and construction of an advance wind turbine in the size 300 to 500 kilowatts. We estimate the advance wind turbine program will take approximately four years and would produce several phototype machines that can operate efficiently at lower wind speeds and can generate electricity at about 5 cents per kilowatt hour.

At that price, wind energy becomes cost competitive in many parts of the country. These cost goals are consistent with the Department of Energy's five-year program for wind energy R&D and, if successful, the advance wind turbine program would put the United States back in the forefront of wind technology and would give our nation a wind turbine that we can export to developing countries.

In sum, we believe that S. 488 gives new direction and focus to the Federal R&D efforts at a critical time.

Thank you very much.

[The prepared statement of Mr. Seligman follows:]

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Testimony of

Dan Seligman

AMERICAN WIND ENERGY ASSOCIATION

Concerning S.488
The Renewable Energy and Energy Efficiency
Technology Competitiveness Act of 1989

Before the

Subcommittee on Energy Research and Development
Senate Energy and Natural Resources Committee

The Honorable Wendell Ford, Chairman

June 15, 1989

1730 N. Lynn Street, Suite 610, Arlington, VA 22209 USA Tel. (703) 276-8334 Telex 6503304640 MCI UW

Mr. Chairman and members of the Subcommittee:

On behalf of the American Wind Energy Association (AWEA) and its members, I would like to thank you for the opportunity to testify on S.488, the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989.

AWEA is a trade association which represents wind turbine manufacturers, component suppliers, developers, utilities, and other companies around the nation that are in the business of generating electricity from the wind.

There are now about 16,000 commercial wind turbines in the United States with an installed capacity of approximately 1,500 megawatts. In 1988, our industry generated about 1.8 billion kilowatt hours, a sum sufficient to meet the annual residential needs of Washington, D.C.

Despite its substantial capabilities, the wind energy industry in the United States is at a critical juncture. We face strong competition from abroad, particularly from Europe and Japan. Governments in Europe are undertaking ambitious R&D programs of their own and planning to build the next generation of wind turbine. It would be no small irony if the United States, which led the industrialized world in developing wind technology in the 1980s, became dependent on imported turbines in the 1990s.

We believe we can avoid that scenario, but it will take a partnership of government and industry working together in order for our industry to remain a viable force in the international marketplace in the next decade. S.488 helps achieve those goals, and we strongly endorse this legislation.

In the testimony that follows, I will attempt to address five key issues relating to the legislation: 1) the multi-year authorization levels; 2) the opportunities to improve efficiency and reduce the cost of wind turbines; 3) the joint venture provisions in the bill; 4) the contribution that wind energy can make toward alleviating our nation's air pollution problems; and 5) the issue of international competitiveness.

1. The need for multi-year authorization levels and adequate annual appropriations.

In the 1970s, after the OPEC oil embargo, the U.S. Department of Energy (DOE) initiated an ambitious research and development program in wind energy that put the United States -- its national laboratories and industry -- in the international vanguard of wind technology.

DOE funds for wind energy perform a vital function: the department and the national laboratories conduct technical and economic studies that are on the forefront of aerodynamics, structural dynamics, advanced components and other supporting research. From these studies the commercial industry obtains a better understanding of loads imposed on a machine and the designs needed to build more cost-effective and reliable turbines.

The wind energy program, however, has been cut substantially in the last nine years. We are now at the point where fiscal 1989 appropriations are approximately one-eighth of what they were in fiscal 1981. The figures below document the decrease in federal R&D funds for wind.

Federal Appropriations for Wind R&D

Fiscal 1981:	$83.7 million
1982	34.7 million
1983:	31.4 million
1984:	26.5 million
1985:	29.1 million
1986:	24.8 million
1987:	16.7 million
1988:	8.6 million
1989:	8.8 million

The proposed fiscal 1990 budget calls for appropriation levels of $8.35 million, yet another reduction.

AWEA believes that multi-year authorizations and adequate appropriations are necessary for the industry to regain its leadership in the increasingly competitive international marketplace. Multi-year authorization levels help provide stability and continuity to federal R&D program; they allow the DOE to undertake R&D projects extending over several years with the confidence that these efforts will not be discontinued in mid-stream.

We support the three-year authorization provisions of S.488 because they allow DOE to undertake new R&D initiatives in wind energy with some degree of confidence that these programs will continue in the 1990s.

2. Improving efficiency and reducing the cost of wind turbines.

Since the early 1980s, the cost of installing a wind turbine for a wind farm has decreased from about $1,500 to $900 per kilowatt. Meanwhile, the performance of the machines has improved steadily.

Availability, a measure of the time a turbine is available to generate electricity, has increased from about 70% in the early 1980s to about 97% in the best wind farms. Capacity factors have increased steadily too, and the most productive wind farms now have capacity factors of between 25% and 33%.

Despite this progress, our industry needs to do better if we are to expand our market and become more competitive. The cost and performance of these wind turbines in many parts of the country is still not competitive with coal-fired generation nor with oil or gas at current prices.

The next step, AWEA believes, is to build the next generation of machine, an advanced wind turbine with improved performance that can generate electricity at lower costs. The joint venture provisions of S.488 help industry meet that goal because they allow the private sector and the DOE to cooperate on specific R&D projects such as the advanced wind turbine.

3. The joint venture provisions of S.488.

If S.488 were enacted, AWEA believes that building an advanced wind turbine should be the top priority for a joint venture R&D project involving our technology. As envisioned by AWEA, this wind turbine development initiative would be a four-year program that would result in the design and construction of prototype machines by the mid-1990s.

The proposed advanced wind turbine would be in the intermediate size (probably in the 300-500 kW category) and would incorporate major advances in turbine design and operation.

The wind turbine would offer three distinct advantages: 1) it would operate economically in lower wind speeds; 2) it would generate electricity at a cost of about 5 cents per kilowatt hour, compared with current costs of 7-9 cents per kWh; 3) it would be larger and more efficient than most commercial machines on the market, thus reducing overall life-cycle costs.

We believe the industry is ready to undertake successfully such a joint venture. There are numerous engineering and consulting firms, utilities, developers, and other companies with sufficient background and finances to serve as partners with the DOE in this venture.

Although AWEA cannot say for sure which firms would bid on such a joint venture partnership, we would like to call to the Subcommittee's attention the entrance of several utilities into the wind field.

The entrance of these and other firms is a positive sign; it shows that companies with a track record of project development are serious about investing in wind turbine technology.

4. The greenhouse effect.

In recent months, there has been much discussion in the scientific community and Congress about the build-up of carbon dioxide and other gases that appear to contribute to the "greenhouse effect" and changes in global climate.

Wind energy can help alleviate these and other problems relating to air quality. The electricity our industry produces is clean: there are no emissions and no waste. Each installed wind turbine displaces large quantities of pollutants. If the wind turbine offsets a mixture of oil and gas, it avoids the emission of an estimated 595 pounds of sulfur oxides, 368 pounds of nitrogen oxides, and 84 pounds of particulates each year. If the turbine offsets coal, it avoids the emission of estimated 9,100 pounds of sulfur oxides, 2,800 pounds of nitrogen oxides, and 175 pounds of particulates each year.

How much of an impact can wind energy reasonably be expected to have in the future? Probably the most realistic assessment was offered by the Department of Energy in 1987 in its Energy Security report. In that document, the DOE estimated that by 1995, annual energy production could reach 10 billion kilowatt hours (about five times current production), and by 2005, it could reach 70 billion kilowatt hours (about 35 times current production).

Capturing more energy from the wind is theoretically possible, and several studies have attempted to quantify wind's maximum contribution. Those reports, prepared in the mid-1970s by DOE consultants, estimated that as much as one trillion kilowatt hours could eventually be generated from wind turbines if multi-megawatt machines were installed throughout the United States.

Although AWEA does not expect that wind turbines will produce that quantity of our nation's energy supply in the near future, the industry can help significantly to alleviate our nation's environmental problems.

There are excellent, undeveloped wind resources in the Panhandle of Oklahoma and Texas, in parts of Wyoming and Montana, and in mountain ranges on the East Coast. Developing wind farms in these parts of the country would also create local jobs and help diversify our nation's energy supply at a time when foreign imports are increasing.

One often-neglected attribute of wind energy is the speed with which the industry can install large-scale wind farms. In 1984, for example, developers installed approximately 400 megawatts of turbine capacity. Similar quantities were installed in 1985. These 800 megawatts -- equivalent in size to a medium-size coal facility -- were installed in just twenty-four months, a rapid response time when compared with the lengthy lead time needed for many conventional sources.

5. International competitiveness.

In the last nine years, while the U.S. cut its federal R&D budget for wind, other industrialized countries have been increasing their research efforts. Danish and Japanese firms have entered the U.S. marketplace in recent years with newer and larger machines, and foreign machines now account for approximately 50% of all the turbines installed in the last four years in the United States. If this trend continues, the U.S. is in serious danger of losing the competitive advantage it has held to foreign manufacturers, many of them supported directly or indirectly by their national governments.

One of the largest markets for U.S. technology is abroad, particularly in developing countries. A federal interagency group, The Committee on Renewable Energy, Commerce, and Trade (CORECT), has played a key role in funding trade missions, market assessments, and other projects designed to give more visibility to renewable energy technologies in developing countries. The proposed Administration budget for CORECT, however, calls for a 50% cut in fiscal 1990 from $1 million to $500,000. S.488 attempts to address part of the problem by providing stable authorizations for these valuable export activities.

7. Conclusion.

Our industry cannot remain competitive if the U.S. government does not support wind technology with stable authorizations and appropriations for research, development, and international activities.

In recent years, we have seen our technology and jobs go overseas. S.488 helps reverse this trend. It provides multi-year authorizations for the federal renewable energy program, sets realistic performance standards for the DOE research efforts, requires the DOE to form joint venture R&D projects with the private sector, and increases the assistance for those federal agencies that help market U.S. renewable energy technologies all help our industry.

We urge the Subcommittee on Energy Research and Development to approve this important legislation.

Thank you, Mr. Chairman, for giving us the opportunity to testify before this Subcommittee. That concludes my testimony, and I would be glad to address questions about the wind energy industry in the United States or our position on S.488.

Senator BUMPERS. Thank you very much, Mr. Seligman.
Mr. Wolf.

STATEMENT OF JAMES L. WOLF, EXECUTIVE DIRECTOR, ALLIANCE TO SAVE ENERGY

Mr. WOLF. Thank you, Senator Bumpers. My name is James Wolf. I am Executive Director of the Alliance to Save Energy. We are a nonprofit coalition of business government consumilators promoting energy efficiency and are pleased that Senator Wirth, a member of the Senate Energy Committee, is our chairman. We are bipartisan, and Senator Heinz is our co-chairman.

My testimony is based on the extensive field work we do in testing new technologies in the field as well as a recent survey of manufacturers engaged in energy efficiency R&D that we recently conducted. We had a meeting with these manufacturers here last week, and we met with the Department of Energy officials as well. I do commend the seemingly new attitude at the Department and willingness to consider change.

The first point to highlight is the energy efficiency industry is a very diverse industry. It is ceramic motor components; it is oil burners; it is windows; it is lighting.

This industry has practically supplied the greatest amount of energy to America over the last 15 years. The technology is still progressing. New windows, for example, that have been tested in Butte, Montana in fact show a net solar gain even when they are installed on the north-facing wall of the home. These insulated windows supply more insulation than the traditional wall.

In the context of the bill, Mr. Chairman, we think the multi-year authorizations are very helpful to the industry; however, the industry itself is very much concerned about the appropriation process. They recognize that authorizations right now are not frankly that significant. In the meeting we had with the industry, they said statements of assurance from both the Congress and the administration about the certainty of appropriations also helps them in the planning process.

It is important to highlight that R&D is simply not a one-year planning process.

On the authorization levels themselves, we believe that they are frankly too modest in this bill. Given the concerns about global warming, national security and other issues, many of the programs in the bill we find would in fact suffer a real decrease from their 1989 appropriation level. We think this is simply not warranted given the challenges that face the country.

Another important point to highlight, we are very cognizant of the massive Federal budget deficit; but even at these authorization levels conservation and efficiency R&D would still be only 5 percent of the Department of Energy's R&D budget. That, to us, is simply inappropriate.

What we recommend the committee do perhaps in the context of this bill is to establish overall research budget criteria for the Department, and the criteria would look at issues like the impact on the environment that technology would have; the effect on national security; the likelihood of near-term success.

We think, established against those criteria, that conservation and renewables as well would fare significantly better in the budget priority process.

On the joint venture part of the bill, Mr. Chairman, we would comment that there is none currently proposed for efficiency technologies, and we recommend that efficiency technologies be included if the joint venture program is to proceed. Again, these could be diverse as motors, windows, insulation and the like.

I want to reiterate the points Mr. Sklar made about the need for demonstration projects. The industry has repeatedly told us this is one of the main reasons that commercially available technology today is simply not penetrating the market as quickly as it can. Demonstration projects are something that over the past eight years the Department of Energy has simply not supported.

Dr. Berg today in a meeting with the industry stated the administration is willing to reconsider their support of demonstration projects. We think it is essential that these be integrated into every R&D funding decision. Ultimately, it is not just the R&D but it is how to get the product to market. That is the challenge for the Federal Government.

On the cost sharing proposals, I concur that while cost sharing may be appropriate there has to be an exception for small business. As Mr. Sklar said, even in the energy efficiency many of the most innovative products are being developed by very small firms. 50 percent cost share is simply unduly burdensome to them.

They are quite willing, one of them even said, to give up an equity position in the government if that is what it takes to show faith and interest in getting their product to market.

So I think we could have a presumption of cost sharing, but there should be a waiver for small business that would not be a blanket rule of a 30 or even 50 percent cost share.

The final point I want to highlight again on aspects of commercialization of technologies is the Federal Energy Management Program. I know that many Senators as well as the industry have expressed their general lament about the state of Federal Energy Management; but frankly, the industry has also surprised us by saying this in fact was one of the best routes to help them commercialize their products.

They recommend when the R&D decisions are being made that consideration be given by both GSA and DOE to the Federal purchase of that technology. Right now I think it is very ironic that the Federal Government is willing to spend millions of dollars to develop a technology, it is developed, and then they do not buy it for use in their own facilities.

Frequently, this was contrasted with the Defense Department where the basic R&D is to develop a product that in fact be used by the Defense Department. It makes no sense for the Federal Government not to use products developed with Federal R&D money.

On the Federal purchasing program I think there are really two points. One is the demonstration of new technology that is developed with Federal R&D incorporating the commitment of Federal purchase and use into the R&D decision; and the second is for just general promotion of existing technology, not new technology. We need an aggressive Federal least cost energy plan not for the Nation as a whole but how to minimize the Federal energy use.

By doing this and implementing it—not just a plan but committing the government to purchase the technologies—every single manufacturer has told us that that will significantly help them in their market share and marketing of new technologies.

Thank you, Mr. Chairman. We hope you will consider these comments in the context of the markup on the bill, but we do support the thrust of the legislation. I think it will be very beneficial to the efficiency industry.

[The prepared statement of Mr. Wolf follows:]

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James L. Wolf
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Testimony of James L. Wolf
Executive Director
Alliance to Save Energy
before the
Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources
United States Senate
June 15, 1989

I appreciate the invitation to testify before the Committee regarding energy efficiency as it relates to S.488 and S.964. The Alliance to Save Energy is a national nonprofit coalition of government, business and consumer leaders dedicated to increasing energy efficiency. We conduct research, pilot projects, educational programs and policy advocacy to achieve this goal.

My testimony today is based upon the extensive field work we do in testing new technologies and working with manufacturers, utilities, the national laboratories and other organizations to design programs to facilitate the introduction into the market of energy efficient products. It also is based upon a survey we conducted of firms engaged in federal conservation research and development activities, and a meeting we had with these industry leaders on June 8th. I am submitting with this testimony a copy of the results of that survey entitled The Department of Energy's Conservation R&D Programs: Results of a Survey of Industry Leaders.

We commend the strategies that S.488 contains on energy efficiency to expand conservation research and development activities and to facilitate the introduction of the technologies into the market. I will make some specific recommendations that I hope will be incorporated in the legislation to further its goals.

Many of the technologies that are now standard -- such as flame retention oil burners that save over 20% from earlier models -- were invented by private industry in successful collaboration with the national laboratories. There are numerous examples of federal investments in research and development that have resulted in energy efficient products -- benefiting both our national security, international competitiveness and the environment.

The country can make significant strides today to improve its energy efficiency using existing cost-effective technology. Programs to accelerate the market penetration of these technologies are needed; this is a related but distinct question from the focus on commercialization of technologies from the research phase that the bill does address. Many of the proposed programs to assist commercialization from research will also foster the faster adoption of the technologies in the marketplace. I believe, however, that separate programs should also be designed to achieve this objective.

The continued research and development of new technologies is one reason why the "conservation potential" for our economy can continue to expand. Our challenge is to continue to expand the slate of cost-effective technologies as the economy grows and existing technologies achieve their market potential.

SURVEY AND MEETING WITH INDUSTRY LEADERS

The Alliance recently surveyed senior executives of organizations engaged in federal conservation R&D. Over 30 executives responded to the questions, and a copy of the report analyzing their responses is attached to my testimony. The responses are very informative from a qualitative perspective but do not represent a statistical sampling. We also met with over 25 industry leaders on June 8th to discuss the federal R&D program and technology commercialization issues.

Three key findings emerged from the survey and meeting that suggest some specific modifications to S.488. First, DOE should expand its support of demonstration and other commercialization activities. Second, the federal government should foster the market for energy efficiency technologies through a purchasing program. Finally, while there is strong support for a significant federal role in R&D, the roles of DOE and the national laboratories in conservation R&D should be reviewed, clearly articulated, and communicated to industry.

DOE should expand its support of demonstration projects and other commercialization activities.

Since 1981, DOE's conservation R&D efforts have concentrated on long-term basic research on generic technologies; funding for specific products and demonstration-oriented activities has diminished. New energy efficiency technologies that have been funded through the proof-of-concept stage often never make it to the market because of the high costs and risks of commercialization. In some cases, these concepts are picked up and commercialized by overseas competitors. As a result, the U.S. lags in getting new energy-efficiency technologies into production.

As one executive noted in response to the survey: "In the development of a new technology or product there is a continuum of activity: basic research, applied research, laboratory model, proof-of-concept unit, field test units, pilot production and full scale production. . . . The technical risk is reduced as one goes from step to step but the economic investment increases in each progressive step. . . . There is often a funding gap between the feasibility development and product development." It is especially difficult for smaller firms to raise the capital to complete the cycle of full scale commercialization.

These problems can be addressed by providing strong and stable funding for demonstration and commercialization activities. This would be a significant departure from current practice. While industry should be expected to contribute financially to these projects, the cost-sharing requirements should be eased for smaller firms -- perhaps through a mechanism that would recapture the government's investment after a product is successfully commercialized.

I recommend that all research not be sponsored and awarded in response to a request for proposals. Because of the complexity and expenses involved in responding to requests for proposals, many firms -- particularly smaller ones -- noted that reserving a portion of the funds for unsolicited proposals would be very beneficial. It would both encourage innovative proposals and facilitate these firms participating in federal R&D.

The perceived need for federal participation in demonstration and commercialization activities is resounding from the survey.

The federal government should help foster the market for energy efficiency technologies through a purchasing program.

Many firms noted that the government is a massive consumer of energy-related technology, but does not use its purchasing power to assist in the market development of efficiency innovations that have been nurtured through federal R&D funding. The comments received are more significant than just the general lament about the state of federal energy management.

In this context, it is helpful to make an analogy to the Defense Advanced Research Projects Agency (DARPA) within the Department of Defense. This program is working with industry to support development of technologies critical to future identified defense needs. The firms have a market for their product when it is developed. As has been observed by many, the technologies will have significant benefits in the civilian sector as well. DARPA is able to accelerate introduction of products to the civilian sector both because of the R&D funding support and the knowledge that a receptive market for initial product sales exists.

Despite the vast need for improvements in federal energy efficiency, and the money allocated for research, there is no consideration given during the R&D funding decisions to the purchase of the technology developed. This clearly should be remedied by DOE working with GSA.

Even DARPA may have a role in energy efficiency. If DARPA's focus is technologies critical to our national defense, does not energy efficiency fit within that category? We well know the threat to our security posed by excessive reliance on imported oil. Reducing that dependence could be an important component of DARPA activities -- the Department of Defense is, after all, the largest energy consumer in the country.

Apart from R&D, the industry leaders clearly stated that improving the federal government's energy use would significantly assist their marketing activities. We need to develop, and implement a least-cost energy plan for federal facilities. This may require examining how the agencies and managers are now held accountable for energy costs.

The roles of DOE and the national laboratories in conservation R&D should be reviewed, clearly articulated and communicated to industry.

There was strong support for a significant -- even expanded -- federal role in R&D. However, many firms indicated that they do not have a clear understanding of DOE's program goals or current R&D activities. The process by which broad goals are translated into program and funding priorities is unclear. Differences between societal goals -- such as national security and environmental quality -- and the private sector's goals must be recognized in program design. DOE should work more closely with industry and the national laboratories to determine the scope and direction of R&D, and to ensure the results of the laboratories' work are transferred to industry.

The technology transfer role of DOE is critical. In addition to the National Laboratories, the State and Local Program Office can perform a valuable function in this area.

The management direction of DOE's programs must ultimately reside with DOE officials and not private industry. It is clear, however, that industry needs to be more involved in advisory councils and other types of programs. Only then will our national laboratories, the Department and industry be able to cooperatively work together and maximize the benefits we can achieve from federal R&D.

SPECIFIC RECOMMENDATIONS ON S.488

Based on the Alliance's industry survey and our other activities in the efficiency area, I have several specific recommendations on S.488 and S.964.

o Multi-year authorizations: The concept of multi-year authorizations is beneficial, although the real problem from the industry perspective has been the lack of program continuity due to both the previous Administration's attempts to drastically curtail it and the uncertainty of appropriations. I encourage the Congress to adopt a 2 year budget and appropriations cycle. Research and development, by its nature, is not well suited to a one year planning horizon.

o Authorization levels: The authorization levels in these bills for conservation are too modest given the potential of energy efficiency to ameliorate many national problems -- particularly global warming. The overall increase is approximately 15.6% over 2 years for conservation programs -- only a slight real increase assuming a modest inflation rate. Some specific programs are in fact **decreased** in real terms in 1991 from 1989 levels.

In S.488, the overall level for conservation would still be over 48% lower than 1980 -- at a time when there now is general consensus that our focus on efficiency should be dramatically increasing due to global warming dangers, increasing oil imports, and concerns about international competitiveness. The Department of Energy's own planning processes and multi-year plans show that many research projects in energy efficiency are unfunded or underfunded at present.

The proposed decrease in policy management and direction, while a small item, is one that I want to highlight. The legislation proposes to decrease this from $3 to 2 million. I recommend, however, that this be increased. The results from the industry survey clearly called for more direction and coordination of the research programs, and a careful examination of how they relate to other critical issues -- such as the environment. These dollars can markedly improve the "bang for the buck" we receive with the dollars doing the actual research.

I recommend the Committee adopt the authorization levels proposed in S.324, the National Energy Policy Act of 1988, which already has over 30 co-sponsors.

While I recognize the difficulty of a significant increase in the programs due to the budget deficit, I propose a reallocation of research funding priorities within the Department of Energy. If the rest of the Department's budget were to remain unchanged from its 1989 levels, the increase in conservation proposed in this bill to $177 million for 1991 would put it just over 5% of the total R&D program in the Department. This is simply inadequate to the task at hand. I recommend the Committee enact legislation to provide criteria and guidance for the overall research priorities at the Department considering factors such as global warming, national security, and the likelihood of near term success.

o New Initiatives: The legislation is to be commended for encouraging the Secretary in Section 5 to submit new initiatives. Numerous initiatives are forwarded each year to the Congress and the Administration by the Alliance in conjunction with the American Council for an Energy Efficient Economy, The Energy Conservation Coalition, and other groups. Some for this year, for example, include research on alternatives to CFCs for refrigeration and insulation, microwave ceramic sintering, and weatherization program improvements. The Secretary should also be asked to submit the top 5 programs which just missed his cut-off for new initiatives, with an explanation for why they were ranked at lower priority than those he recommended. This will give the Congress more information about the research potential and encourage the development of new ideas.

o Joint Ventures: Section 6 is to commended in concept. To improve its effectiveness, I recommend that the 30% commitment of non-federal funds not be an absolute requirement. Provision should be made to allow some exceptions to the rule. As revealed in the industry survey, an absolute 30% requirement may be a significant barrier to some firms. Similarly, some proposals should be allowed to go forward without a competitive request for proposals -- unsolicited proposals should be encouraged.

While joint venture arrangements are established for many of the renewable technologies, there is none established to promote commercialization of energy efficient technologies domestically. I suggest one specifically be established for this purpose. The technologies need not be named, but could include technologies as diverse as windows, lights, motors, insulation, furnaces, or engine components. (Section 6(C)(6) comes the closest to incorporating energy efficient technologies, but it is focused on export of technology.) I recommend the authorization be at least $15 million for this purpose.

o Federal Purchasing to Facilitate Commercialization:

I recommend the legislation incorporate specific provisions providing for some form of ready access to the federal market for products developed with federal R&D funds, as well as for other products to demonstrate energy efficiency or renewable energy technologies. This could be accomplished through expanding Section 8 to include energy efficiency technologies and encompass more than just the dissemination of information.

The Federal Energy Management Program, and GSA, should be active partners in the acquisition of research products developed with federal dollars. They could be required to make a purchasing commitment when the research funding is approved. Indeed, the federal commitment to purchase products was identified by industry as one of the best ways to assist commercialization. It is simply not being done now.

CONCLUSION

By enhancing research to develop new conservation technologies and structuring programs to assist their introduction into commercialization, S.488 will provide numerous benefits to the country. The benefits include a major step in mitigating the threat of global warming, enhanced national security, more affordable housing, and a more competitive economy.

Senator BUMPERS. Thank you very much, Mr. Wolf.

Mr. Sklar, I was not here when you testified a moment ago, but I wanted to ask you three or four questions.

Number one, what is the cost of photovoltaics now compared to 10 years ago, for example?

Mr. SKLAR. Our costs have dropped tenfold in the last 10 years. It has been part and parcel of the DOE program, and it started out of the 1973 crash program to commercialize this technology from space.

To give you a sense where we are now commercially, we are cost competitive against diesel or propane fuel in remote applications anywhere. Since most of the third world gets its electricity from diesel or propane generators, we have a massive market. $6 billion of the World Bank money goes to third world energy, and most of it goes to diesel and propane generators, most of them made by Japan.

Senator BUMPERS. What is the cost per watt?

Mr. SKLAR. The cost per peak watt now is about $4. We have a plant being bid now in California, and we are hoping that will be closer to $3. So even in the next few years we will see breakthroughs.

Pacific Gas & Electric, the utility in California, will be making an announcement this month which says that anything that is more than 200 feet off the utility grid will now be run by photovoltaics. So that is lighting even summer homes that are beyond 350 feet.

Senator BUMPERS. I do not understand. What does that mean?

Mr. SKLAR. That means when there is a new development, instead of running a line they are finding that in some cases by just running the line and providing a stepdown transformer would cost more than putting in a photovoltaic system. So in street lighting, bus stop lighting, all those kinds of applications where you need electricity and you do not have enough to invest in all the infrastructure, photovoltaics, because of its low maintenance and the fact that there is sunlight everywhere, will become a technology of choice.

Senator BUMPERS. How reliable is that, though, on a 24-hour basis?

Mr. SKLAR. Luckily, although the battery technology is still our weak point, over the last three years we now have these self-contained, no maintenance deep cycle batteries, very much like no maintenance car batteries except they are deep cycle 10 year warranties. We still have a long way to go on the battery storage side, but for right now it is still economical though our most costly component.

Senator BUMPERS. Are you familiar with the Luz Corporation?

Mr. SKLAR. Very much so, sir,

Senator BUMPERS. They have about 175 megawatts now of solar thermal power. They have an application for another 160 and another 140 or 150 in the planning stage.

Mr. SKLAR. Right. Actually contracts signed.

Senator BUMPERS. This is an Israeli company, is it not?

Mr. SKLAR. No, it is an American company that has a research component in Israel. Its founder is an American citizen who went back to Israel.

Senator BUMPERS. Who developed the technology they use?

Mr. SKLAR. It is a U.S. company. It is a U.S. individual who has developed the technology. He was born and raised in California, went to Israel and set up a little research institution, but the company is owned by American investors.

Senator BUMPERS. Describe for me briefly how that technology works.

Mr. SKLAR. It is a simple technology. They use a trough, a curved Corning glass, and it concentrates sunlight on a glass pipe filled with synthetic oil. It is a closed loop pipe, and it just goes in front of all those concentrators, heats up beyond 800 degrees, goes through a conventional steam generator. The steam is transferred from the heat of the pipe to the water and turns a regular generator.

Senator BUMPERS. What is their cost per kilowatt?

Mr. SKLAR. They are providing at the moment 12 cents per kilowatt hour. The plant they are in the midst of building will be an 8 cents per kilowatt hour plant, and in the next year and a half they believe they will be in the 4 or 5 cents per kilowatt hour range.

Senator BUMPERS. How does that compare with coal, for example?

Mr. SKLAR. Coal generally is in the 5 cents and below kilowatt range, so we are getting competitive. What is great is that for peak power, which is the high value power that solar will be used for, we are very competitive. That is why Loos is building its plants.

Peak power generally is the oldest plants, the most polluting plants, the most expensive plants, and those are the plants the utility industry is going to really be changing, not baseload plants. So the solar option will have a real profound effect.

Senator BUMPERS. Phillips Corporation, apparently a Dutch company, has a big light bulb plant in Arkansas, and I have to confess I have never been through it. They have about 700 employees down there.

Somebody sent me a light bulb recently, and I believe it was made by Phillips. You know the light bulb I am talking about, and it had all this information on there. I sit as the ranking member on the Energy Committee, and I had never heard of this light bulb.

We have always left a light on in the living room at night, so I put it there since they said it will last 10 to 15 times longer than a regular light bulb.

Mr. WOLF. That is right, Senator. Let me speak about that.

Senator BUMPERS. I do not see those things on the market anywhere. Why not?

Mr. WOLF. One of the things we have been trying to do for the last 14 months is to get this room and others in the Senate relamped. Senator Wirth has taken that as a charge.

I, for example, live in Northern Virginia, and we did relamp our condominium two years ago. These light bulbs typically are more expensive on a first cost basis. On a life cycle cost basis they beat hands down any light bulb on the market.

It is a question of appropriate use. It is for, for example, hallways where lights are on 24 hours a day, office buildings where they are typically on more than eight hours a day. The general rule of thumb is seven to eight hours a day. If your light is on longer than that, these light bulbs will pay back very, very rapidly.

In addition to lasting 10 times longer than a regular light bulb, it also reduces your laborsaving costs, for example, in having maintenance crews go out and change the light bulbs.

The effective cost of these is one-quarter, and in terms of energy costs, 60 watts can be produced by 15 watts, the same equivalent amount of light.

Senator BUMPERS. You get 60 watts of light from 15 watts of power?

Mr. WOLF. From a 15 watt bulb; that is correct. So you are saving 75 percent of the energy.

Senator BUMPERS. What does that particular bulb retail for?

Mr. WOLF. It retails typically in the $16 to $18 range. But, for example, some utilities are promoting very innovative programs. There is a utility in Massachusetts that is giving them to their customers for free to reduce peak power loads. They lease them to them. They say they know the initial first cost might be a barrier to you, so we will charge you 20 cents per month on your electric bill for every one of these light bulbs you accept. The customer comes out ahead, and the utility comes out ahead.

So there are some innovative programs trying to address getting these into the market quicker. Again, one of the main aspects, we had a lighting manufacturer at that meeting we spoke about last week. He said why will the Federal Government not purchase these for use of all the people who should be looking at life cycle costs, and that can be a demonstration to other business and industry.

Senator BUMPERS. Somebody like Tim Wirth or Dale Bumpers ought to put that on an amendment, GSA's appropriation for example.

Mr. WOLF. We would encourage you to do that.

I want to point out again that these light bulbs initially were only being manufactured overseas. Now there are many American manufacturers of them not only in your district, but there are several in New York State. There is a company headquartered in New Jersey.

Senator BUMPERS. What are the Japanese doing in solar research now?

Mr. SKLAR. The Japanese are on a full court press to take over the world photovoltaic market. We can see that in their federal funding. Again, they are spending almost twice what we are, just starting about two years ago.

Their industry has been gearing up on amorphous silicon, which is the layering of silicon on glass so you can start doing mass production as part of the glass manufacturing process.

They have only really entered and held in the consumer market obviously all the gadgets you have seen, but the fact is they have started a coordinated export approach that could very well lead us to what the Danes have done to the wind industry worldwide. So we are very scared that unless the United States really wants to maintain their technological lead in a technology we created that we need to maintain the R&D and to build the export assistance.

I would like to point out in Popular Science this month Sanyo has just announced a photovoltaic roofing shingle. They see that entering the marketplace next year. So instead of using regular shingles for your house you will have a roofing shingle that will last 25 years and be able to provide 50 percent or more of your electricity.

Senator BUMPERS. That is really an interesting concept, is it not?

Mr. SKLAR. It sure is.

Senator BUMPERS. You can tell by the size of the audience in a committee hearing like this how exciting this is to America. They really are not interested in renewables, and yet everybody knows that renewables in energy efficiency are absolutely essential to our survival as a planet.

It is hard to get people interested in the greenhouse effect. You know, so far as I am personally concerned the greenhouse effect is almost fortuitous. Even if it were to be proven totally erroneous, it would still be fortuitous because everything that we would do to deal with the greenhouse effect is good public policy, something we should have been doing all along and something we ought to do on a massive scale in the future.

One final question. I forgot who it was, and maybe it was you, Mr. Seligman, but somebody said that this bill does not provide for demonstration or joint ventures in efficiency technology.

Was that you, Mr. Wolf?

Mr. WOLF. Yes, it was.

Senator BUMPERS. That disturbs me. I did not realize that. It only deals with joint ventures on renewable technology?

Mr. WOLF. That is correct.

Senator BUMPERS. You think it ought to be amended to take advantage of technology efficiency?

Mr. WOLF. Absolutely.

Senator BUMPERS. I think that point is well taken.

One other thing somebody suggested. One of you talked about how the Japanese have determined a way to concentrate sunlight 60,000 times to the point that you can even use it for lasers.

Mr. SKLAR. We have done that. In fact, the U.S. last year through the U.S. DOE program broke the theoretical limit, which was theoretically 30,000 suns. We are up to 60,000 suns, and not only will it be able to power lasers but we think we will be able to do new kinds of material science where we will be able to bond and create new kinds of substances. So we are entering a whole new field of ceramics as a result of this technology.

Senator BUMPERS. Mr. Seligman, one other question of you. What percent of the 16,000 wind turbines were manufactured outside this country? Do you know?

Mr. SELIGMAN. Roughly half.

Senator BUMPERS. About 50 percent of them?

Mr. SELIGMAN. About 50 percent.

Senator BUMPERS. Are we competitive with the rest of the world in wind turbines?

Mr. SELIGMAN. We are at this point in most size machines. The problem we have is similar to the solar industries. I am not sure to what extent that trend will continue in the 1990s.

Senator BUMPERS. Are we developing new technologies all along on wind or not? Are we?

Mr. SELIGMAN. Slowly.

Senator BUMPERS. Is the private sector doing that, or is the Federal Government doing it, or both?

Mr. SELIGMAN. A little bit of both.

There is a proposed joint venture between U.S. Wind Power, which is the largest wind turbine manufacturing company in the United States, and several utilities to build the next generation of wind turbine.

The Danes are also looking at and have been doing that, and a considerable amount of R&D work on the next generation of wind turbine technology has been taking place in Europe in other European countries, West Germany and England particularly.

Senator BUMPERS. I was in Palm Springs, California last year. As I flew in I saw this tremendous windmill field? Is that what you call them?

Mr. SELIGMAN. Wind farms.

Senator BUMPERS. Wind farm? Are you familiar with that one in Palm Springs?

Mr. SELIGMAN. Yes.

Senator BUMPERS. Who owns that?

Mr. SELIGMAN. A variety of private wind farm developers.

Senator BUMPERS. How is it doing?

Mr. SELIGMAN. The performance is pretty good. In all three of the California locations, Palm Springs, Tahatchapee and Altmont Pass, which is near San Francisco, both the availability and the capacity factors of the machines has been improving pretty steadily.

Senator BUMPERS. We have some additional questions for the record that we will submit to the three of you, I think, and I thank all of you very much for being here this morning.

Mr. SKLAR. Thank you for your support, Senator.

Senator BUMPERS. Our last panel consists of Mr. Robert Chaney, Manager, Energy Programs, EG&G Energy Systems—Idaho, Idaho Falls, Idaho; and Mr. Terry Q. Alarcon, Chief of Staff and Executive Counsel to the Mayor New Orleans.

Gentlemen, if you will.

Mr. Chaney, please proceed.

STATEMENT OF DR. ROBERT E. CHANEY, MANAGER, ENERGY PROGRAMS GROUP, EG&G IDAHO, INC.

Dr. CHANEY. I am very pleased to be here today to have this opportunity to discuss this legislation with you.

To introduce myself, I am with EG&G Idaho, Incorporated, the prime contractor at the Idaho National Engineering Laboratory for the Department of Energy. I am the manager of the Energy Programs Group within the Science and Technology Department.

We are involved with many of the conservation and renewable energy research programs of the Department of Energy, and in conjunction with the Idaho Operations Office we manage and/or conduct research and development activities for a variety of these programs.

This morning I would like to take the opportunity to address primarily the third point in the bill's purpose, which is to foster collaborative research and development between government and industry. However, I would also like to make a couple of general comments. Both of them have been addressed earlier by other witnesses.

The purpose of the legislation, the prime purpose, is to establish long-term authorization for the conservation and renewable energy research program areas. We believe this is an excellent approach. Of course, it would give long-term stability to the programs and increase the continuity and affected planning of these research activities.

However, the bill should include all of the conservation and renewable energy areas, including wellhead hydropower and energy storage which do not appear.

In another section, the goals and timetables established for the renewable energy areas if they are to be included in the bill should be broadened to include all of these alternate energy technologies and efficiency technologies.

Additionally, section 6, the joint ventures section, should be broadened to include all appropriate energy technologies as indicated earlier, including geothermal hydropower, alcohol fuels and hydrogen fuel so that these alternatives can all get a fair shake in the marketplace.

Now to focus more on the collaborative research areas.

As you know, these technologies are brought to the commercialization step in stages. It is very seldom that a scientific research breakthrough is directly commercialized. It goes in a process of steps, engineering, development and so forth.

Our challenge in the national laboratories is to try to find ways to speed this process up and get technology out to industry. In our experience, one of the most effective ways to do this is cost shared research with industry.

Part of the effectiveness of that is when teams of scientists and engineers come together to work on these technologies, and the more fundamental scientists can bring their understanding of the technology to the engineers from industry who understand the end use needs. Together, they can form an effective team to bring these technologies to commercialization.

I would like to point out this works both for a large project and small projects, single cost share companies cost sharing a project or groups of companies cost sharing projects, and I will get back to that point in a minute.

For examples of this approach, we can look at the conservation area within the multisector category, the Energy Conversion and Utilization Technology Program, ECUT. Their mission is to provide some of the support for projects which bridge the gap between fundamental research and commercialization.

We have an excellent example of a cost shared project with the FMC Corporation and the INEL working on biological processing of phosphate ore, applying biotechnology to making elemental phosphorous in a very energy conservative manner.

I would like to point out this is an early stage of development. The company is very interested. The cost sharing is relatively low. So as you move along the innovation cycle, companies are more likely to invest larger amounts of money when it is near commercialization. When it is very preliminary they would like to participate but they do not want to put in quite as much money. I am not specifying FMC. I am talking in general. That is a factor that should be considered when considering cost share activities.

In the industrial programs area of the conservation research, the steel initiative has several examples of large cost shared projects involving several participants. The initiative requires 30 percent cost sharing by industry and, as you know, is designed to infuse advance technology into metals processing.

I had some over on the table and I have other copies of the management plan for that initiative.[1] The Idaho operations office has management responsibility for it. The program was modified last year in the authorization process to include other metals than just steel, and the management plan for that activity is in the review cycle and should be available shortly.

In the area of research in that particular program the INEL is participating with consortium of eight industries on university, MIT, and another national laboratory, Oak Ridge, as a team to develop advanced spray forming technology for the direct production of low carbon steel strip. We are very excited about that project. It is about two and a half months old, and it has gotten off to a very good start.

There are other areas within renewable areas, energy areas, such as in geothermal and hydropower and also electric vehicles within conservation in which we had a lot of experience with cost shared projects.

Based on our experience, we feel there are three concerns that industry has when they enter into a cost sharing agreement: intellectual property rights; schedules; and costs.

Under intellectual properties rights, this seems to be the primary concern to private industry, particularly in large projects with multiple participants. The point was made earlier that there could be some waiver for small businesses on cost shared agreements at 30 percent versus 50 percent. If you had a mixture of small businesses and large businesses trying to get together on a cost shared program, I can see a lot of problems in putting together the right kind of package.

An issue related to that as a problem is that small businesses and nonprofit organizations normally retain the right to their inventions under the funding agreements with the government. This has the potential for fragmenting intellectual property rights when you have small businesses working with large companies or universities or nonprofit organizations working with large companies.

In the steel initiative they have addressed this program through what they call a declaration of exceptional circumstances by the assistant secretary. This determination permits title to the entire technology package to vest through an advanced waiver process with a holding company that is either designated or set up by the participants of the sponsored research. That way, that holding company handles the intellectual rights as opposed to each of the individual companies having to worry about it.

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[1] A copy of "Steel Initiative Management Plan, April 1, 1987" was provided and retained in subcommittee files.

In terms of schedule, industry wants to get on with it. When they have agreed to enter into a cost shared program, they want the schedule to be as fast as technically possible. For this reason we questioned some of the need for advisory committees as specified in section 6 of the legislation.

What is needed is a smooth and efficient process to put these things in place so that once they are agreed upon they can start moving quickly.

Cost is important. As you indicated, the in kind cost sharing is very important to these companies. In terms of personnel time contributions, materials, supplies, equipment, those people involved in the teams, the researchers, are critical to the commercialization process.

Now there are several organizations that have been set up. We have heard from some this morning that are helping to facilitate the development of these various technologies. A couple of others are the Geothermal Technology Organization and the Geothermal Drilling Organization. These are examples of consortia of companies who have gotten together with the national laboratory and developed an organization to facilitate cost shared research.

The first one the INEL is involved in. The second one, Geothermal Drilling Organization, Sandia National Laboratory is involved in. The Electric Vehicle Development Corporation is another example of an organization set up to help commercialize technology.

So I guess in summary there are three points that I would like to bring home. First, companies want their intellectual property rights clarified at the outset. They want to move as fast as possible once they have decided to enter into one of these agreements. Finally, they want, as you indicated, flexible cost sharing provisions so that they can be as effective as possible.

A lot of progress has been made in these areas. I have just cited some examples. Other examples have been cited today, but attention to these points is required to facilitate research and development projects in a cost shared manner between government and industry.

Thank you very much.

[The prepared statement of Dr. Chaney follows:]

STATEMENT OF

DR. ROBERT E. CHANEY

MANAGER, ENERGY PROGRAMS GROUP, EG&G IDAHO, INC.

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

U.S. SENATE

Introduction

Mr. Chairman and Distinguished Members of the Committee. I am very pleased to have this opportunity to discuss S.488, the "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989" with you today.

To introduce myself, I am with EG&G Idaho, Inc., the prime contractor with the Dept. of Energy at the Idaho National Engineering Laboratory (INEL). Currently, I am manager of the Energy Programs Group within the Science and Technology Department. We are involved with many of the Conservation and Renewable Energy Research programs of the Department of Energy (DOE). In conjunction with the Idaho Operations Office, we manage and/or conduct research and development activities for many of those programs.

This morning I will specifically address the third point of the Bill's purpose, which is to foster collaborative research and development efforts between government research organizations and the private sector. In order for the committee to understand our position, I would like to present some general observations concerning the Bill.

General Observations

Section 2. Purpose, Point 1, which provides for the long-term (multi-year) authorization for the Conservation and Renewable Energy research programs, is an excellent approach. This will give long-term stability and assist with long-term planning and continuity. However, the Bill should include all of the Conservation and Renewable Energy programs, on an equal basis, including the Low Head Hydropower Program. Goals and time tables, if they are to be included, should be delineated for each. Additionally, the Joint Research and Development Ventures Section should be broadened to include all appropriate renewable energy technologies including geothermal, hydropower, alcohol fuels, and hydrogen fuel so that all alternatives are evaluated on an equal basis.

cycle. In the area of research, the INEL is participating with a consortium of eight private companies, MIT, and Oak Ridge National Laboratory in developing advanced spray forming technology for the direct production of steel strip.

There are many program areas such as Geothermal, Hydropower, and Electric Vehicles, as well as Conservation, have experience with cost-sharing of research. Based on our experience with these activities, some general observations can be made on the three most important factors: Intellectual Property, Schedule, and Cost.

Intellectual Property

Confidentiality and the rights to Intellectual Property seem to be of most concern to private industry, particularly in large projects with multiple participants. One problem is that small businesses and nonprofit contractors and subcontractors are normally entitled, pursuant to Public Law 98-620, to automatically retain title to their inventions made under a funding agreement with the government. This has the potential for fragmenting Intellectual Property and frustrating the licensing and commercialization of sponsored technology. The Steel Initiative Program has addressed this problem through a Declaration of Exceptional Circumstances by the Assistant Secretary for Conservation and Renewable Energy under 35 U.S.C. 202. This exceptional circumstances determination permits title to entire technology packages to vest, through an advance waiver process, in a holding company designated or created by the industrial cost-sharing participants. This guarantees to the participants the right to use the entire technology developed by the sponsored research. This up-front knowledge that all participants have the right to use all of the technology developed on a uniform and equitable basis will expedite the commercialization of that technology.

Protection of technology "know how" at government laboratories is another problem. Intellectual Property consists of both patentable concepts and "know how". While there is adequate protection for patentable concepts, "know how" developed at DOE National Laboratories is vulnerable to disclosure under current Freedom of Information Act legislation.

Cooperative R&D Ventures

Now to focus on collaborative research efforts. As you know, technologies are brought to commercialization in stages. Rarely are scientific laboratory findings directly commercialized. Usually several development stages are required. Our challenge in the National Laboratories is to find ways to expedite this process and enhance the transfer of technology from the bench to the factory floor. Our experience is that one of the most successful methods of doing this is through cost-shared projects or joint R&D ventures.

Translating fundamental research results to applications is most efficiently accomplished when performed by teams of scientists and engineers from universities, national laboratories, and the private sector. Working together they can appreciate the subtleties of the technology as well as the requirements of the user, etc. If companies are supplying resources to the team, they have heightened interest. This can be effective for small or large projects.

For examples of this approach let us look at the Conservation Program area. First, within the Multisector category is the Energy Conversion and Utilization Technology (ECUT) Program. It is the mission of ECUT to provide support that "bridges" the gap between fundamental research and commercial development. For example, we currently have under way a relatively small cost-shared project regarding the Biological Solubilization of Phosphate Ore. Funding is shared between ECUT and the FMC Corporation. In this work, biotechnology is being applied to minerals processing and it is in the early stages of development.

The other areas of Conservation closer to the applied end of the spectrum. They include Transportation, Buildings, Community Systems and Industrial Programs. In the Industrial Programs area, the Steel Initiative contains examples of larger cost-shared projects. This initiative requires at least 30% cost-sharing by industry and is designed to infuse advanced technology into the metals processing industry. The Idaho Operations Office has field management responsibility for this program. Copies of the management plan for the original program are available. A revised plan for the program, based on last year's expanded authorization, is in the approval

Schedule

The companies involved in cost-sharing R&D agreements want to aggressively pursue innovation. They want project schedules that move the work along as rapidly as technically possible. In other words, they want technology to pace the project progress. For this reason I question the need for so many advisory committees called for in Section 6 of the Bill.

Cost

Cost is important. Perhaps more important than the total, however, is the type of cost-sharing allowed. Most companies favor contributing resources such as equipment, personnel time, materials, and supplies, where possible rather than cash. The direct involvement of industrial scientists and engineers is critical to project success. Provision must be retained for in-kind cost-sharing.

There are several organizations already established to help facilitate this type of development for renewable energy and conservation technologies. They include: The Geothermal Technology Organization, The Geothermal Drilling Organization, and the Electric Vehicle Development Corporation, to name a few.

Summary

These three points are the major concerns of private industry when entering into a cost-shared project. Companies want their intellectual property rights clarified at the outset. Then they want the work to move as rapidly as possible; therefore, smooth and efficient processes for finalization of cost-shared agreements must be established. And, finally, provisions for flexible cost-sharing must be retained. Some progress has been made in these areas, but attention to these points will increase the use of cooperative research and development agreements between government and industry.

Again, thank you very much for this opportunity. If you have any questions, I will be happy to answer them at this time.

Senator BUMPERS. Thank you, Dr. Chaney.

Mr. Alarcon.

STATEMENT OF TERRY ALARCON, CHIEF OF STAFF TO MAYOR SIDNEY J. BARTHELEMY, NEW ORLEANS, LA, ACCOMPANIED BY DR. ANTHONY LASKA, ENERGY COORDINATOR, CITY OF NEW ORLEANS

Mr. ALARCON. Senator Bumpers, thank you. I am pleased to be here to testify before you on the importance of this bill.

With me today is the energy coordinator for the City of New Orleans, Dr. Anthony Laska. We are here to offer our support and that of Mayor Barthelemy for S. 488.

While I personally do not have the technical expertise as the gentlemen who went before me, I think it goes without saying that we feel this bill will have the effect of accelerating the development of numerous renewable energy and energy efficiency technologies which are critical to the economic and environmental welfare of our Nation.

The particular aspect of this bill which is of greatest concern to us and to the City of New Orleans is the provision for funding advanced district cooling technology research and development at the level of 1 million per year for three years.

This technology is particularly important to the City of New Orleans as well as to other southern cities, since it can supply low cost building air conditioning while simultaneously contributing to a resolution of both the global warming and atmospheric ozone depletion problems.

It is my understanding that it does this through the use of a very high efficiency energy conversion process called cogeneration and through the use of innovative ammonia chillers and absorption chillers, both of which employ environmentally benign refrigerants instead of the atmospheric ozone damaging CFCs presently in use.

In 1986, the last year for which data was collected, it was estimated that during the summer of 1986 building air conditioning cost American consumers $17.8 billion. For the western south central region which includes Louisiana, Arkansas, Oklahoma and Texas, average electricity costs due to air conditioning were estimated at $581.50 per household. These costs are increasing due to high electricity rates.

In the future, the need to replace CFC refrigerants may also contribute to significantly increased costs for air conditioning. Thus, there is a need for new building air conditioning technology which is both environmentally benign and low cost.

The City of New Orleans is presently the site of one of the most important evaluations of new highly energy efficient, environmentally beneficial building air conditioning technologies currently in process in the United States.

The United States Department of Energy's District Heating and Cooling Program is providing funding in the amount of $58,000 for the initial phase of a project to design an advanced cogeneration and district cooling system.

This system will employ technologically advanced components in the task of supplying economical air conditioning to a number of buildings which make up the City of New Orleans Judicial Complex, including the Municipal and Traffic Court, the House of Detention, the Parish Prison and police headquarters.

The present air conditioning system serving the complex was built over 25 years ago and is inadequate, inefficient, costly and in need of replacement.

The technologies which are being considered in the study include the following: a high efficiency cogeneration system which employs an abundant local energy resource, natural gas; an absorption chiller which runs off the waste heat from the cogenerator; an ammonia chiller powered by the electricity produced by the cogenerator; and a district cooling piping system consisting of underground pipes distributing chilled water to the Judicial Complex.

The system has been estimated to be at least 40 percent more energy efficient than the best conventional electric building chillers available today.

One of the most important aspects of the New Orleans project is its use of ammonia refrigeration technology. This is an old technology dating back to 1876 when it was first developed in Germany by Von Lind.

Because of ammonia's toxicity at high concentrations in closed spaces, building codes do not permit its use in building air conditioning application. However, ammonia is extensively used in industrial applications, especially in large systems. In well supervised industrial applications, ammonia refrigeration has proven to be no more hazardous than high pressure steam.

In order to use ammonia instead of CFC refrigerants in building air conditioning applications, the cooling plant must be located in a separate building where it would produce chilled water supplies which can then be piped to buildings using district cooling technology which consists of an underground chilled water piping network linking a central plant with a number of buildings.

As a result of this configuration, proven environmentally benign energy efficient ammonia refrigeration technology can be transferred from the industrial sector for use in the building sectors with only slight adaptation.

The New Orleans project seeks to combine existing technologies in an innovative and economical design which can largely be financed by third-party private investment. Initial analysis shows that such a project would have about a four-year payback. Although a four-year payback is unusual for a demonstration of new technology, it may not be sufficient to attract third-party private financing.

However, if the required development of ammonia chiller evaporated technology for chilled water production is also funded by S. 488 and proves to be successful, the cost of the project might be reduced by as much as 20 percent.

If such an evaporator is also demonstrated by being incorporated into a New Orleans project ammonia chiller system, the result would be a payback of three years, which would be sufficiently profitable to warrant private sector investment of about $2.5 million. The cost of developing and demonstrating a new ammonia chiller evaporator would be approximately $500,000.

The summary of the project's funding requirements is as follows. In Fiscal Year 1990, engineering design of the project, $100,000; in Fiscal Year 1990 also, development and construction of a new ammonia chiller evaporator, $500,000; in Fiscal Year 1991, the construction of New Orleans district cooling system and demonstration of new ammonia evaporators with third-party private financing of about $2.5 million; Fiscal Year 1991, additional instrumentation and performance monitoring for comparative study for other options, $100,000.

So the total proposed cost to the Federal Government of the New Orleans district cooling project would be $700,000. Thus, for every dollar of government funds for technology R&D, approximately $3 of private funds will be leveraged. The goal of this project is to make it profitable to replace air conditioning systems which use CFCs with natural gas-fired cogeneration, ammonia chilling, absorption chilling and district cooling alternatives.

This development would greatly accelerate the phasing out of CFCs, a factor which might prove critical to the success of CFC phaseout plans currently in the process of formulation.

There are a number of suggestions which we would like to make regarding the terms of the legislation pertaining to the district cooling joint venture provided for in this bill.

First of all, we encourage the committee to explicitly include local governments as participants in such joint ventures. Since local governments do not have the financial resources to contribute funds to such projects, it will be also important for the committee to make sure that in kind services can be applied in lieu of actual financial contributions. In the situation of New Orleans, Senator, it would be almost critical that this be the case.

It would also be important to be more explicit regarding the technology which should be developed by the joint venture. The type of technology being assessed for application in New Orleans should be mentioned in the legislation and should also list technology demonstration as well as research and development as an improved activity which is eligible for funding.

In addition, although $1 million per year for three years is a considerable sum which will definitely have a positive effect, it should be recognized that in order for district cooling to develop to the level at which it can be begin to significantly contribute to a resolution of the problem of global warming, atmospheric ozone depletion and the high cost of air conditioning, much more funding will be necessary.

Thus, while we applaud the intent of the Renewable Energy and Energy Efficiency Competitiveness Act of 1989, we hope that the committee will recognize that the magnitude of energy, economic and environmental problems which we face as well as the opportunities presented by renewable and energy efficient technologies for resolving them are sufficiently great as to require significantly more funding than is presently being proposed in the bill.

However, this bill does represent an important first step in the direction of a more innovative and farsighted Federal energy program, and as a result certainly deserves the support of this committee and of the Senate.

I thank you along with Dr. Laska for the opportunity to address the committee on this most important matter.

Thank you, Senator.

[The prepared statement of Mr. Alarcon follows:]

TESTIMONY OF
TERRY ALARCON
CHIEF OF STAFF TO
MAYOR SIDNEY J. BARTHELEMY
CITY OF NEW ORLEANS, LOUISIANA

BEFORE THE:
COMMITTEE ON ENERGY AND NATURAL RESOURCES
U.S. SENATE

ON:
S.488, THE RENEWABLE ENERGY AND ENERGY EFFICIENCY
COMPETITIVENESS ACT OF 1989

JUNE 15, 1989

Mr. Chairman and Members of the Committee. I am pleased to be here today to testify before you on the importance of S.488, The Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989. With me today is the Energy Coordinator of the City of New Orleans, Dr. Anthony L. Laska. I am here today to offer my support and that of Mayor Sidney J. Barthelemy for S.488. In general, this bill will have the effect of accelerating the development of numerous renewable energy and energy efficiency technologies which are critical to the economic and environmental welfare of our nation.

The particular aspect of this bill which is of greatest concern to the City of New Orleans is a provision for funding advanced district cooling technology research and development at the level of $1m per year for three (3) years. This technology is particularly important to the City of New Orleans as well as to other southern cities since it can supply low cost building air conditioning while simultaneously contributing to a resolution of both the global warming and atmospheric ozone depletion problems. It does this through the use of a very high efficiency energy conversion process called cogeneration and through the use of innovative ammonia chillers and absorbtion chillers, both of which employ environmentally benign refrigerants instead of the atmospheric ozone damaging CFC´s presently in use.

In 1986, the last year for which data was collected, it was estimated that during the summer of 1986 building air conditioning cost American consumers $17.8 billion. For the Western South Central Region, which includes Louisiana, Arkansas, Oklahoma and Texas, average electricity costs due to air conditioning were estimated at $581.50 per household. These costs are increasing due to higher electricity rates. In the future, the need to replace CFC refrigerants may also contribute to significantly increased costs for air conditioning. Thus, there is a need for new building air conditioning technology which is both environmentally benign and low cost.

The City of New Orleans is presently the site of one of the most important evaluations of new highly energy efficient, environmentally beneficial building air conditioning technology currently in process in the United States. The U.S. Department of Energy's District Heating and Cooling Program is providing funding in the amount of $58,000. for the initial phase of a project to design an advanced cogeneration and district cooling system which will employ technologically advanced components in the task of supplying economical air conditioning to a number of buildings which make up the City of New Orleans' Judicial Complex including the Municipal and Traffic Court, the House of Detention, the Parish Prison and the Police Headquarters. The present air conditioning system serving the complex was built 25 years ago and is inadequate, inefficient, costly and in need of replacement.

The technologies which are being considered in the study include the following--a high efficiency cogeneration system which employs an abudant local energy resource, natural gas; an absorbtion chiller which runs off the waste heat from the cogenerator; an ammonia chiller powered by the electricity produced by the cogenerator; and a district cooling piping system consisting of underground pipes distributing chilled water to the Judicial Complex. This system has been estimated to be at least 40% more energy efficient than the best conventional electric building chillers available today.

One of the most important aspects of the New Orleans Project is its use of ammonia refrigeration technology. This is an old technology dating back to 1876 when it was first developed in Germany by von Linde. Because of ammonia's toxicity at high concentrations in enclosed spaces building codes do not permit its use in building air conditioning applications. However, ammonia is extensively used in industrial applications, especially in large systems. In well supervised industrial applications, ammonia refrigeration has proven to be no more hazardous than high pressure steam. Ammonia is produced from natural gas in prodigious quantities in Louisiana, as well as elsewhere in the U.S. and throughout the world. It is a naturally occurring chemical which has no deleterious environmental impacts.

In order to use ammonia in building air conditioning applications, the cooling plant must be located in a separate building where it would produce chilled water supplies which can then be piped to buildings using district cooling technology which consists of an underground chilled water piping network linking a central plant with a number of buildings. As a result of this configuration, proven, highly energy efficient ammonia refrigeration technology can be transferred from the industrial sector for use in the buildings sector with only slight adaptation to substitute for environmentally dangerous CFC's.

The New Orleans project seeks to combine existing technologies in an innovative and economical design which can largely be financed by third party private investment. Initial analyses show that such a project would have about a 4 year payback. Although a 4 year payback is unusual for a demonstration of new technology it may not be sufficient to attract third party private financing. However, if the required development of ammonia chiller evaporator technology for chilled water production is also funded by S.488 and proves to be successful the costs of the project might be reduced by as much as 20%. If such an evaporator is also demonstrated by being incorporated into the New Orleans Project ammonia chiller system the result would be a payback of three (3) years which would be sufficiently profitable to warrant private sector investment of about $2.5 million. The cost of developing and demonstrating the new ammonia chiller evaporators would be approximately $500,000.

The summary of the project´s funding requirements is as follows:

Year	Task	Cost
FY90	Engineering Design of the Project	$100,000.
FY90	Development and construction of a new ammonia chiller evaporator	$500,000.
FY91	Construction of the New Orleans District Cooling System and Demonstration of New Ammonia Evaporators With Third Party Private Financing of about $2.5m	0
FY92	Additional instrumentation and performance monitoring for comparative studies with other options	$100,00.
Total Proposed Cost to the Federal Government of the New Orleans District Cooling Project		$700,000

Thus, for every dollar of government funds for technology R&D, approximately three (3) dollars of private funds will be leveraged. The goal of this project is to make it profitable to replace air conditioning systems which use CFC´s with the natural gas fired cogeneration, ammonia chilling, absorbtion chilling and district cooling alternative. This development would greatly accelerate the phase out of CFC´s, a factor which might prove critical to the success of CFC phase out plans currently in the process of formulation.

There are a number of suggestions which we would like to make regarding the terms of the legislation pertaining to the district cooling joint venture provided for in S.488. First of all, we encourage the Committee to explicitly include local governments as participants in such joint ventures. Since local governments do not have the financial resources to contribute funds to such projects, it will also be important for the Committee to make sure that in kind services can be applied in lieu of actual financial contributions.

It will also be important to be more explicit regarding the technology which should be developed by the joint venture. The type of technology being assessed for application in New Orleans should be mentioned in the legislation and it should also list technology demonstration, as well as research and development, as an approved activity which is eligible for funding. In addition, although $1m per year for three (3) years is a considerable sum which will definitely have a positive effect, it should be recognized that in order for district cooling to develop to the level at which it can begin to significantly contribute to a resolution of the problem of global warming, atmospheric ozone depletion and the high cost of air conditioning, much more funding will be necessary. Thus, while we applaud the intent of The Renewable Energy and Energy Efficiency Competitiveness Act of 1989 we hope that the Committee will recognize that the magnitude of energy, economic and environmental problems which we face as well as the opportunities presented by renewable and energy efficient technologies for resolving them are sufficiently great as to require significantly more funding than is presently being proposed in the bill as a whole and especially for the district cooling joint venture. However, S.488 does represent an important first step in the direction of a more innovative and far sighted federal energy program and as a result certainly deserves the support of this Committee and of the Senate.

Thank you for this opportunity to address the committee on this important matter. We would be happy to answer any questions the Committee may have.

Senator BUMPERS. Thank you, Mr. Alarcon.

Incidentally, I was with your mayor at a dinner the other night in New Orleans. Please give him my very best wishes.

Mr. ALARCON. Senator, I was there. I tell you, we have told the Sheriff of Calhoun County story more times than we care to repeat.

Senator BUMPERS. Mr. Alarcon, are there any other projects in the country similar to this right now? Has this technology been demonstrated?

Mr. ALARCON. Dr. Laska has been a director of this program, Senator Bumpers, and there are two other projects. He might want to go into more detail.

Dr. LASKA. Two other cities, sir, are working on similar projects but using different technologies at the present time under a DOE program. That DOE program also includes some national laboratory and private sector work as well.

Senator BUMPERS. Are you familiar with the one that the University of Arkansas has or that they are working on?

Dr. LASKA. Yes.

Senator BUMPERS. Have you visited there?

Dr. LASKA. I have not visited there, but I did meet with the people working on it in our kickoff meeting back in October when this program first started off. We are awaiting the next meeting shortly to get a progress report.

Senator BUMPERS. I certainly would have no objection to New Orleans stiffing the government for $700,000, and you ought to be able to do it with the Chairman of this committee being from Louisiana.

Mr. ALARCON. We are going to try.

Senator BUMPERS. I am not going to commit until I get a few things from Arkansas from Bennett. Assuming he is in a trading mood, we should not have much trouble getting your project funded.

You make a very good and compelling case for it, and certainly the elimination of CFCs for these kinds of projects, which if it proves to be a viable technology you could use it in all kinds of districts and areas and would have a tremendous impact on the elimination of CFCs in this country.

I think the technology for air conditioning and the elimination of CFCs, as duPont says, they already have one that eliminates chloroflurocarbons but on domestic air conditioners and automobiles. I do not think they have come up with anything that is really on a highly commercialized basis yet. So maybe this is at least a part of the solution to that.

You and Dr. Chaney both, Mr. Alarcon, suggest in kind services, and I have no objection to that. I would ask staff to probably insert that in the bill. That might be a given. I do not know. Maybe that is an automatic, but we will make sure that that is included in the bill.

Dr. Chaney, this question of advisory committees which you mentioned, you know, the Department of Energy always has more and certainly used to when we were appropriating a lot more money for research and development of renewable energies and energy efficiencies and so on. They had so many contracts out they did not even know who had the contracts, let alone monitor them. It was sort of a disgrace, really.

When it came to light, they had 250,000 contracts, something like that, and some of them were not even in their computer. They did not even know who had the money or what they were doing.

So we do not want to go back to that again, but at the same time we will never be able to fund DOE with enough money for enough full-time equivalent personnel to monitor these things, so why not take advantage of some advisory committees in the private sector to at least give their impressions and, what shall I say, lend their thoughts as to how well the thing is going and maybe make some constructive suggestions.

What is wrong with that?

Dr. CHANEY. Nothing. All I was alluding to was, as I recall from the legislation, each of the subtechnologies had a separate advisory committee to shepherd $1.5 million, and it seemed to me——

Senator BUMPERS. It may be overdone. We will look at that.

Dr. CHANEY. I liked the comment made earlier of the two advisory committees, one for renewables and one for energy efficiency. That seemed appropriate.

Senator BUMPERS. You certainly hit a nerve when you talked about small business and their ability to get involved in this.

I am going to ask my staff on the Small Business Committee to look at this bill and see how we can fix it so that we address the concerns you have and also make sure that small business gets an opportunity to participate.

So far as intellectual rights are concerned, I am not an expert on that but it does not seem to me that that ought to be an insurmountable problem as long as these intellectual rights are agreed to on the front end.

Dr. CHANEY. Right. The key is to set up mechanisms for these agreements to be reached quickly, efficiently; have enough examples for companies to look at so that they are comfortable with the process. The concept of holding companies is very useful in dealing with this.

Senator BUMPERS. Finally, Dr. Chaney, you mentioned that all these other technologies ought to be included in the bill. While I agree with that, the people down on Pennsylvania Avenue and at OMB caution us constantly about how we cannot do this and we cannot do that because of the budget constraints.

Dr. CHANEY. My comment was really aimed at the authorization section under renewables which included several items. Almost all of the items that are currently part of the DOE program with the exception of, as I recall, energy storage and low head hydropower which were notably absent.

Senator BUMPERS. Was geothermal on the list?

Dr. CHANEY. Yes, it was.

Senator BUMPERS. Or was it excepted; or was it not included? It is included?

Dr. CHANEY. Yes.

Senator BUMPERS. So you are concerned about storage, the battery thing. Senator McClure is always interested in that, too.

Dr. CHANEY. And low head hydropower, which is facing many of the same problems that the wind energy industry is facing.

Dr. CHANEY. So you do not want more money; you are just saying it ought to be included in the bill?

Is that correct, Ben? Are they not included?

You know, this is a very modest bill, really, in the scheme of things. When you consider the task in front of us, this is not a very strong commitment to renewables and energy efficiency technology. You know, we do the beset we can with what we think we can get past OMB and the presidential veto and so on in an area that is extremely important to us.

Well, you have both raised some interesting points, and we will try to make certain that they are addressed. I feel sure this bill has great support in this committee and is probably going to be reported out.

We still have to appropriate the money. I have the advantage of sitting on the Appropriations Committee also with Senator Johnston, and we will be deciding how much money we are going to put into this bill after we get it authorized. Certainly, your points are all well taken.

I thank you both for coming long distances to testify today and enlighten the committee. We will be marking this bill up, I assume, very shortly, and I hope that when it finally comes out it will meet with your approval.

Thank you very much. We stand adjourned subject to the Chairman's call.

[Whereupon, at 11 a.m., the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

Department of Energy
Washington, DC 20585

July 18, 1989

The Honorable Wendell H. Ford
Chairman
Subcommittee on Energy Research
and Development
Committee on Energy and Natural Resources
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

On June 15, 1989, Dr. John R. Berg, Assistant Secretary for Conservation and Renewable Energy appeared before your subcommittee to discuss S. 488, the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989.

Following that hearing, you submitted written questions on behalf of Senator Dale L. Bumpers for our response to supplement the record. Enclosed for your information are the answers to those questions, which also have been sent to Senator Bumpers.

If you have any questions, please have your staff call Frances Bryant on 586-4277. She will be happy to assist.

Sincerely,

Rebecca A Thompson

for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosures

cc: The Honorable Pete V. Domenici
Ranking Minority Member

POST-HEARING QUESTIONS AND ANSWERS
RELATING TO THE
JUNE 15, 1989, HEARING
BEFORE THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
UNITED STATES SENATE

WITNESS: DR. JOHN R. BERG
ACTING ASSISTANT SECRETARY FOR CONSERVATION
AND RENEWABLE ENERGY
U.S. DEPARTMENT OF ENERGY

QUESTIONS FROM SENATOR BUMPERS

Question 1:	Hydropower's 89,000 MW of capacity accounts for over 90 percent of the renewable electric capacity in the U.S. Yet this important technology has been omitted from the budget for DOE's renewable energy R&D program. When was the last time a hydro R&D program was funded?
Answer:	The last DOE hydropower appropriation was $450,000 for FY 1987. The Department continues to monitor two previously funded engineering R&D projects and three technology development projects. And the Department is funding activities through the CORECT Program to enhance the international competitiveness of the U.S. hydropower industry. However, other Federal agencies such as the Tennessee Valley Authority, Bonneville Power Administration, Bureau of Reclamation and Corps of Engineers fund the bulk of government activity in this area, over $15 million annually for R&D activities. The activities address such problems as turbine design, cavitation reduction, dissolved oxygen and water quality improvements, conservation, dam efficiency and materials safety and design improvements.

QUESTIONS FROM SENATOR BUMPERS

Question 2(a):	Hydropower is often thought of as a mature technology because it is the oldest of the renewables. However, there are a number of critical technical issues in the environmental area which need R&D attention, such as the establishment of accepted methodologies and standards for environmental studies, an analysis of dam design criteria, and the effectiveness and costs of mitigation measures. Would it be appropriate for DOE to establish a research program to address these technical concerns?
Answer:	We do not believe that it would be appropriate for DOE to initiate new research programs in these areas. Hydropower in the U.S. has come a long way since the first water-wheel generator went into operation in 1879 to illuminate Niagara Falls by arc lamps. Today, hydroelectric power provides about 10% of the total generation of electricity in the U.S. with a current aggregate capacity, including pumped storage of 88,000 MWe. Hydropower facility construction costs are competitive and operating costs are the lowest of all generating options. The Department is also well aware that hydropower is not without its own set of environmental and safety concerns which become major issues in the FERC relicensing and development process. However, considering the maturity of hydropower technology, long-standing activity of other federal agencies and other higher budget priorities, the Department believes that other agencies such as the TVA, Corps of Engineers, Bureau of Reclamation, etc., should take the responsibility for resolving the environmental and safety issues.

QUESTIONS FROM SENATOR BUMPERS

Question 2(b):	Would you support the authorization of funds for a hydro R&D program at DOE?
Answer:	For the reasons previously stated, the authorization of funds for hydropower research is not a funding priority currently supported by the Department. The Department recognizes the vital role played by hydropower in the industrial and scenic life of the U.S. and we are aware of the advantages of hydropower. Secretary Watkins has initiated the development of an integrated National Energy Strategy (NES) with conservation and renewable energy as key components. You can be sure that hydropower will receive careful evaluation and consideration as we proceed with development of the NES.

QUESTIONS FROM SENATOR BUMPERS

Question 2(c):	Are there previously appropriated funds available for hydro R&D?
Answer:	Funds have become available from a previous hydropower appropriation, but as previously noted this would not be a funding priority of DOE.

QUESTIONS FROM SENATOR BUMPERS

Question 3:	In many countries hydropower represents a much larger segment of electrical generation capacity than in the United States. Information on international technical innovations would be helpful to the hydropower industry. Can CORECT funds be used to establish an international technology transfer program to facilitate the exchange of information on environmental and other technical issues?
Answer:	The mission of CORECT is to encourage the use of U.S. renewable energy products and services and to ensure that U.S. renewable energy technologies are considered for viable applications around the world. The CORECT program is currently working with the National Hydropower Association to further its mission in support of hydropower. For example, CORECT funds were used to support the development of a U.S. hydropower industry capabilities exhibit which was used at the Renewable Energy in the Caribbean Conference and will be used at the International Waterpower '89 Conference to be held in Canada later this year.

APPENDIX II

Additional Material Submitted for the Record

City Of New Orleans
Sidney J. Barthelemy
Mayor

June 19, 1989

The Honorable J. Bennett Johnston
U.S. Senate
136 Senate Hart Office Building
Washington, DC 20510
ATTN: Jim Oakes, Administrative Assistant

Dear Senator Johnston:

This letter follows up upon issues raised during my testimony on behalf of Mayor Barthelemy before the Senate Energy and Natural Resources Committee on Thursday, June 15, 1989. In supporting S.488, The Renewable Energy and Energy Competitiveness Act of 1989, Dr. Anthony Laska, New Orleans' Energy Coordinator and I, presented a number of suggestions which were well received. I wish to enumerate these in the hope they will assist you in the impending markup of S.488. We believe that the effectiveness of S.488 will be greatly enhanced, and New Orleans will benefit significantly by the following:

1. Allow in-kind contributions in lieu of cash contributions by participants in joint venture projects.

2. Include the demonstration of new technology by cities as well as research and development by private companies as an essential activity eligible for funding under the bill.

3. Specifically include mention of the following technologies which should be given highest priority in access for funding through the joint venture: ammonia chiller evaporators for use in district cooling; high efficiency, small to intermediate scale, low pollution natural gas-fired cogeneration systems; and heat activated chillers which do not use CFC's for cogeneration and district cooling systems.

New Orleans, Louisiana 70112
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4. Include a provision for involving the City of New Orleans as a participant in the joint venture and earmark funding in the amount of $700,000 over three years for the engineering design of the New Orleans District Cooling project and for the development, construction and demonstration of new evaporators for use in the ammonia chillers supplying district cooling to the City of New Orleans' Judicial Complex.

5. Increase the level of funding allocated to the District Cooling Joint Venture created by S.488 from $1 million per year to $2 million to year.

As we have noted in the past, the South has received only minimal DOE attention for district cooling in comparison with the millions poured into district heating in years past. While we recognize the budget constraints at present, we feel the programs embraced by S.488 offer viable solutions to future environmental challenges as well as energy imbalances at a relatively modest price.

We look forward to your continued support and are available to clarify our program at your convenience. Do not hesitate to call for further information, and let me know if our appearance in Washington will be helpful.

Sincerely,

Terry

Terry Q. Alarcon
Chief of Staff

cc: Ben Cooper

PUBLIC CITIZEN

Buyers Up ☐ Congress Watch ☐ Critical Mass ☐ Health Research Group ☐ Litigation Group

June 13, 1989

The Honorable Wendell H. Ford, Chair
Subcommittee on Energy Research & Development
Energy and Natural Resources Committee
312 Hart Building
United States Senate
Washington, DC 20510

Dear Mr Chairman:

This letter and the attached document shall serve as testimony Public Citizen wishes entered into the record for the Subcommittee's June 15 hearing on S. 488 (Fowler), regarding renewable energy research and development.

Public Citizen is a non-profit research and advocacy organization founded by Ralph Nader in 1971 to address a broad range of consumer and environmental issues. The Critical Mass Energy Project is Public Citizen's energy policy arm.

S. 488 would significantly improve the DOE's renewable energy R&D program of the past several years for two central reasons:

- it establishes a multi-year authorization which is essential in order to restore stability to the renewable energy research program and to ensure its maximum efficiency; and
- it directs the DOE to focus on the near-term commercialization of renewable technologies--many of which are ready for the market but remain under-utilized--thereby allowing society to reap their benefits.

However, Public Citizen believes that the level of funding contained in S. 488 is inadequate for the following reasons:

- it is likely to be insufficient to achieve the goals the bill aims to accomplish; and
- it is not adequate to significantly increase the use of renewable energy within the next decade which is essential in order to mitigate global warming and other environmental problems.

Public Citizen urges the subcommittee to support a substantially increased R&D budget for renewable energy technologies, minimally

215 Pennsylvania Ave. SE ☐ Washington, DC 20003 ☐ (202) 546-4996

restoring funding to 1985 levels, or $263 million in 1990 dollars. H.R. 1078 (Schneider), currently pending in the House, would achieve this level of funding over three years. S. 324 (Wirth), would also come closer to this goal than would S. 488.

Enclosed with this letter is the executive summary of a 100-page report recently completed by Public Citizen. The report is based on over a hundred government documents and interviews with industry members and industry analysts. A few of the report's key findings are:

- renewable energy now accounts for almost 10% of U.S. domestic energy supplies;
- energy from renewable technologies is likely to at least double by the year 2000--from about 6.5 quads today to 14 quads by 2000;
- minimally, energy from renewable technologies can displace 10% of carbon dioxide emissions causing global warming by the year 2000. Government studies indicate that that figure could be much greater with more government support; and
- since 1980, the cost of energy from renewable technologies has dropped up to 75%--making many renewable electric facilities competitive with new conventional (natural gas, clean coal, and nuclear) electric plants.

It is time to put the nation's renewable energy program back on track. Public Citizen urges the subcommittee to support a multi-year authorization bill which reorients research toward near-term market goals, accompanied by funding levels that will allow renewable energy to play a significant role in the solution to global warming, as well as other environmental problems stemming from U.S. reliance on fossil and nuclear fuels.

Sincerely,

Nancy Rader

Nancy Rader
Energy Policy Analyst
Critical Mass Energy Project
of Public Citizen

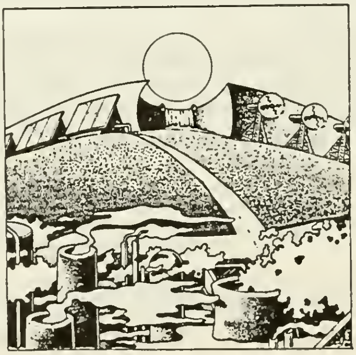
enclosure

PUBLIC CITIZEN
Critical Mass Energy Project
215 Pennsylvania Ave., S.E. • Washington, D.C. 20003 • (202) 546-4996

Power Surge

The Status and Near-Term Potential of Renewable Energy Technologies

Executive Summary



By

Nancy Rader

With

Kenneth Boley Daniel Borson
Ken Bossong Scott Saleska

May 1989

POWER SURGE: EXECUTIVE SUMMARY

1. Introduction

Since the beginning of the industrial age, the consumption of energy has resulted in significant and increasing impacts upon the health and safety of the human population and the well-being of the environment as a whole. As the 21st century approaches, however, the consumption of energy is contributing to a far greater threat than any previously known. The international scientific community is in virtually unanimous agreement that, due in large part to emissions from the burning of fossil fuels, the climate of the earth is destined to change markedly within the foreseeable future, irreversibly altering the ecosystems upon which society depends. While emissions generated in the past already commit the earth to a certain rise in temperature, which will inevitably bring some disruption, the full magnitude of the change and its effects can be tempered if action is initiated now to reduce those emissions.

At the same time, the consumption of energy is compounding other, more "traditional," energy-related problems. Exxon's recent Alaskan oil spill--the largest in U.S. history--has devastated the state's regional environment and economy at a time when oil imports are rising. Foreign oil now comprises almost 40 percent of U.S. petroleum consumption. Acid rain caused by the burning of coal in the U.S. is not confined to this country, but destroys forests and lakes in Canada as well.

The nuclear power industry promotes itself as a solution to these problems, but poses many of its own. Over thirty years since the first U.S. reactor went into operation, there is still no known safe, proven method of storage for wastes which will remain radioactive for hundreds of thousands of years. It is also currently the most expensive of the conventional sources of electricity, and costs are rising. When existing plants reach the end of their useful 20 to 30-year lives (a time approaching for many plants), dismantling and disposing of these plants will bring further economic and environmental costs.

The American public is thus faced with a choice. It can continue with its current pattern of energy consumption that all but assures serious disruption to society and the global ecosystem within the next 20 to 50 years. Or it can demand a fundamental change in that pattern by insisting that its leaders take responsibility for the U.S.' share of the problem by leading a concerted global effort to preserve the viability of the planet. This change involves reducing the intensity of energy use and gradually replacing dangerous energy supplies with sources that are far less hazardous to the environment.

Energy efficiency and renewable energy resources can meet this challenge. While energy efficiency has received some of the attention it deserves as a solution to the many problems posed by conventional fuel sources, renewable energy has been largely ignored since the days of the Carter Administration which had established a goal of meeting 20% of U.S. energy needs with solar energy by the year 2000.

In fact, while renewable energy technologies offer one of the most promising components of any strategy to mitigate the trend toward climate change, comprehensive information about the cost, energy contribution, and near-term potential of renewables has not been compiled for several years.

Public Citizen has therefore conducted a comprehensive review of renewable energy resources and the status of the major technologies that tap those resources. The findings in this report are based on over a hundred government and industry documents and interviews with government officials, industry leaders, and industry analysts.

In this report, Public Citizen examines the cost declines that have occurred within the past decade, the current individual and combined contribution of renewables to the U.S. energy supply, and the projected and potential growth of renewable energy supplies over the next 10 to 20 years. Finally, Public Citizen investigates the public policies that will be necessary for renewables to achieve their full potential and allow them to contribute significantly to the abatement of energy-related dangers, most notably global warming.

2. Summary of Findings

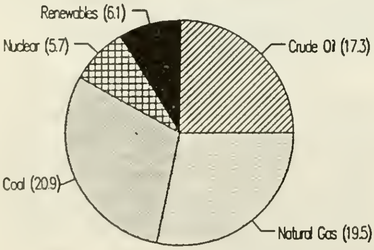
These are the major findings of *Power Surge*:

Renewable Energy Now Contributes 9% to 10% of Domestic Energy Supplies

- Domestically-produced renewable energy supplies contributed over 6 quads of energy to U.S. energy supplies in 1988 and would have contributed almost 7 quads had it been an average year for hydropower--1988 was very low due to drought conditions.
- This represents 8.8 percent of the 69 quads of energy that were supplied by domestic sources in 1988 and would have represented almost 10% in an average year for hydropower.
- While hydropower presently accounts for about 40% of total U.S. renewable energy use, biomass, geothermal, wind, and direct solar technologies account for much of the current growth. By the year 2000, non-hydro sources may account for 75% of total energy from renewables.

See **Figure 1** for the contribution of renewable energy as a part of total U.S. domestic energy supplies. (See Appendix **Table 1** for the current and projected energy contribution of each renewable resource.)

Figure 1. U.S. Domestic Energy Production By Source (1988), In Quads



Source: U.S. DOE/EIA and Public Citizen.

Renewable Energy Now Satisfies About 8% of Total U.S. Energy Needs

- Including imports of electricity generated from Canadian hydro plants, renewables currently satisfy 7.7% to 8.6% (depending on hydropower production levels) of total U.S. energy needs (including all imports). (The U.S. consumed a total of 83 quads in 1988.)
- By comparison, nuclear power contributed about 5.7 quads of energy in 1988, or 6.9% of total U.S. energy consumption.
- Renewable energy now supplies enough energy to run America for one month, representing $18 billion worth of energy, according to Dr. Robert San Martin of the U.S. Department of Energy. Renewables supply enough electricity to power 58 million homes for a year.

The Electric Capacity of Non-Hydro Renewables Has Multiplied 10-fold Within the Past 10 Years

- In 1980, 1,109 MW of renewable electric capacity existed, excluding hydroelectric capacity; today there are over 9,500 MW of non-hydro capacity--the equivalent of more than 10 average-size (900-MW) nuclear power plants.
- Almost 90% of non-hydro renewable electric capacity has been built in the years since 1980 following and as a result of the enactment of the 1978 Public Utility Regulatory Policies Act (PURPA).

(See Appendix **Table 2** for the past, current, and projected electric capacity represented by each renewable resource.)

Renewable Electric Capacity Is Now Equivalent to Nuclear Capacity

- Total renewable electric capacity (including hydropower) has grown from 77,309 MW in 1980 to 97,443 MW at the end of 1988. This compares to the 1988 nuclear power on-line capacity of 97,220 MW. (Note that renewable sources of energy also provide non-electric energy in the form of solid, liquid and gaseous fuels, as well as natural heating, cooling and lighting from solar building designs.)

Renewable Energy Supplies Are Likely To At Least Double By 2000, Supplying At Least 15% to 19% of Total Projected U.S. Energy Needs

- Public Citizen estimates, based on industry and government sources, that renewable technologies are likely to contribute 14 quads annually by 2000 (a doubling of the energy they produce today in an average hydro year). This will account for 15% to 19% of projected U.S. energy needs by the year 2000, depending on the extent to which the U.S. improves the efficiency of its energy use*. By comparison, the energy contribution from nuclear power will remain virtually stagnant.

See **Figure 2** for a graphic representation of the current and projected energy supply from renewables.

- This is a conservative estimate of the contribution that renewable energy is likely to make. It was based on assessments of each technology which assume a continuation of the current economic and political climate, including low prices for competing conventional fuels and the residual effects of severe funding cuts during the Reagan Administration.

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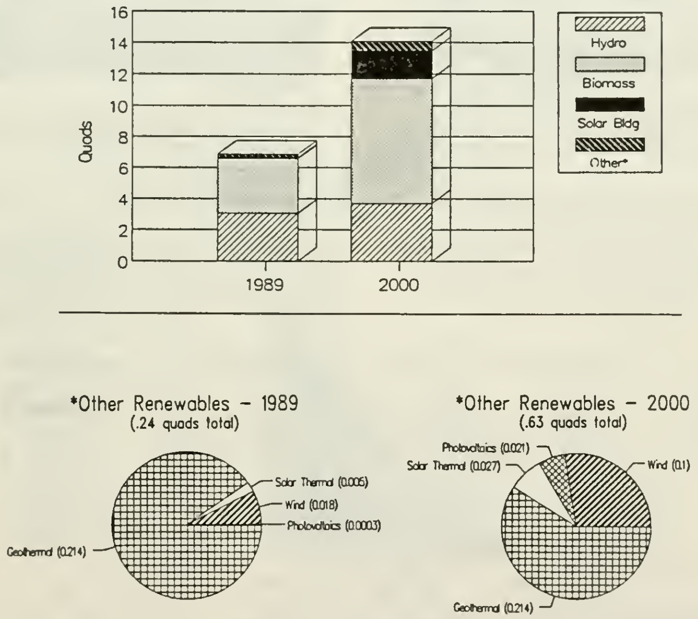
*If serious efforts to increase energy efficiency are undertaken so that energy intensity is reduced at the rate that was achieved between 1976 and 1986, only about 71 quads would be used in total in 2000, as opposed to the 94 quads that would be used with little improvement in energy efficiency.

Figure 2. Current and Projected Domestic Renewable Energy Supplies (Quads)



Source: Public Citizen, based on government and industry data.

Renewable Energy Could Provide Virtually All U.S. Energy Needs by 2010

- Backed by aggressive public and government support, renewables could provide up to 80% of the national annual demand for energy in the year 2010 (including transportation fuels), or up to 80-90 quads of energy, based upon government reports. (Total U.S. energy consumption is now about 83 quads.)

  (See Appendix **Table 3** for the potential energy contribution of each renewable resource.)

- This potential can be realized only with a substantial increase in the Department of Energy budget for research and development of renewable technologies, restoring that budget to at least 1985 levels of $263 million, in adjusted 1990 dollars. The Public Utility Regulatory Policies Act (PURPA) must continue to be used to encourage the development of renewable energy, and other policies must be implemented to promote renewables.

Renewable Electric Capacity Is Expected to Grow by Over 30,000 MW by 2000

- Non-hydro renewable domestic electric capacity is conservatively expected to grow by about 14,500 MW in the next ten years, totaling over 24,000 MW.

- Total domestic renewable electric capacity (including hydropower) is projected to grow by over 31,500 MW by 2000, to a total of 129,000 MW.

  See **Figure 3** for a graphic representation of this projected growth in capacity by source.

- By comparison, nuclear plant capacity is not likely to increase above its projected peak of approximately 105,000 MW that will be reached in the early 1990s.

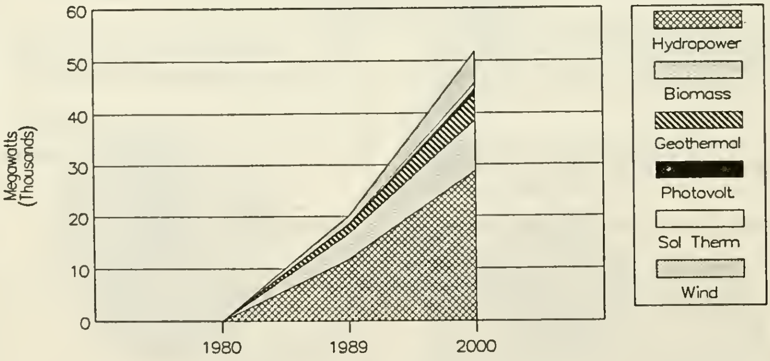
- Government reports show that renewables can meet the increasing demand for electricity, which is accounting for a growing share of national energy use.

The Cost of Many Renewable Energy Technologies Has Declined Dramatically Since 1980

- The cost of power from wind turbines has fallen from 25 cents per kilowatt hour (kWh) in 1980 to 7-9 cents/kWh today. Costs are expected to decline to 4-5 cents/kWh by 2000. See **Figure 4**, next page.

- The cost of power from photovoltaic cells has fallen from $1.50/kWh in 1980 to about 35

Figure 3. Growth In Renewable Electric Capacity, By Source: 1980 - 2000*



*Conservative projection based upon current political and economic climate.
Source: Public Citizen, based on government and industry data.

cents/kWh today. That figure is expected to decline to between 6 and 18 cents/kWh by 2000. See **Figure 5**.

- The cost of power from Luz International solar thermal electric plants operating in the Mohave Desert region of Southern California has declined from 24 cents/kWh in 1984 (the first year of their commercial operation), to 12 cents/kWh in 1988. Plants coming on line in 1989 are expected to generate power at 8 cents/kWh, and costs will decline further to only 5 cents/kWh for plants coming on line in 1994. See **Figure 6**.

(All cost/kWh figures in 1989 constant dollars.)

Electricity from Many Renewable Electric Technologies Is Today Competitive With Power from New Conventional Facilities; Other Renewables Will Become Competitive by 1995-2000

- Electricity from biomass, geothermal, and hydroelectric facilities (at between 3 and 6 cents/kWh) is today economically competitive with most new conventional baseload* electrical supplies (and less expensive than new nuclear power plants).
- Some solar thermal systems are now economically competitive with conventional sources of new intermediate/peak* load electric capacity.
- Wind turbines are competitive as a source of intermittent intermediate/peak load power (wind power displaces both baseload and intermediate/peak power).
- Biomass fuels can also competitively provide intermediate load power.
- Photovoltaic systems have made significant breakthroughs in research and cost reductions, and are likely to be competitive as a peakload source of power by 1995-2000, as is power from solar thermal central receivers and parabolic dishes.
- Providing heating, cooling and lighting through solar building technologies can cost effectively displace the need for both baseload and peakload energy. These technologies can save up to 50% of a building's energy needs at a cost of nothing to $10/MBtu, and many designs are estimated to displace electricity at less than 5 cents/kWh. (By comparison, the cost of natural gas delivered to consumers is $5.70/MBtu and the average cost of electricity charged to consumers is 8 cents/kWh.)

(Appendix **Table 4** presents the past, current, and projected costs of each renewable electric technology.)

A comparison of electricity production costs for conventional and renewable baseload and peakload facilities is presented in **Figures 7 and 8**, next page. (Also see Appendix **Table 5** for the cost of new conventional capacity.)

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*Baseload power plants are intended to be run as much as possible to meet the levels of power that are in constant demand during a season or a year. Intermediate load plants are intended to meet the next highest increment of power demand above that which can be provided by baseload capacity. Peakload plants are intended to produce power for the periods of highest electrical demand within a particular period of time, such as a day or a season.

Electricity Production Cost Declines of Solar and Wind Systems (cents/kilowatt hour).

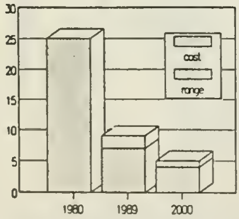


Figure 4. Wind Turbines

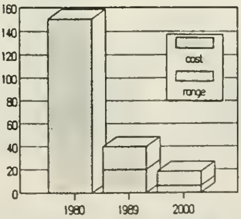


Figure 5. Photovoltaic Cells

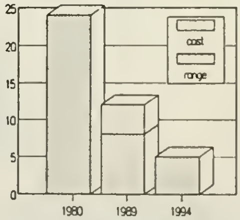
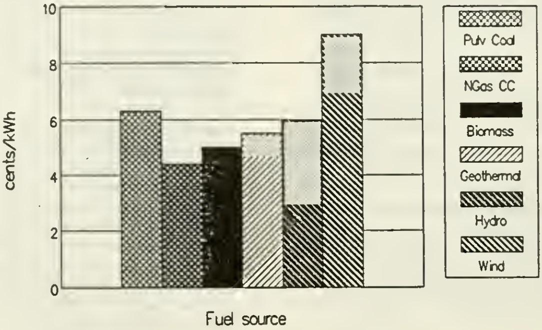


Figure 6. Solar Thermal Plants

The Social Costs of Renewable Energy Technologies Are Lower Than Those Of Conventional Energy Sources

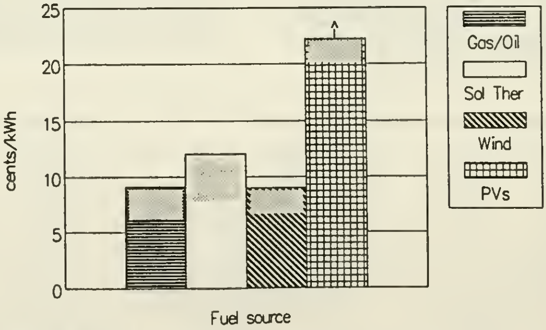
- Based on a 1988 study undertaken for the Commission of the European Communities, if the readily-identifiable external costs of conventional energy sources were accounted for in market prices, the cost of photovoltaic and wind power would be far less than that of fossil and nuclear power. A similar study should be undertaken by an agency of the U.S. government so that public policies can be based on the true social costs of energy.

Figure 7. Renewable and Conventional Baseload Electricity Costs.



Dotted areas represent cost range.
Data sources: coal and gas--Electric Power Research Institute (converted from current to constant dollars); renewable sources--Public Citizen, based on government and industry data.

Figure 8. Renewable and Conventional Peakload Electricity Costs.



Dotted areas represent cost range.
Data sources: gas/oil figure--Electric Power Research Institute (converted from current to constant dollars; renewable sources--Public Citizen, based on government and industry data.

Renewables In Combination with Energy Efficiency Offer Near-Term Potential for Displacing Large Quantities of Carbon Dioxide Emissions Causing Climate Change

- The growth of energy supplied by renewable sources can contribute directly to the mitigation of global warming by displacing fossil fuels that emit carbon dioxide (CO_2) into the atmosphere. Renewable energy technologies, in end use, add virtually no net CO_2 to the atmosphere.

- Public Citizen estimates that renewables can displace at least 8-15% of projected U.S. carbon dioxide emissions by the year 2000 (the range depends upon how vigorously energy efficiency is pursued). Further, government studies suggest that renewables have the potential to reduce virtually all CO_2 emissions by 2010.

  U.S. fossil fuel use produced about 5.4 billion tons of CO_2 in 1985. Based on government energy use projection figures, 6.4 billion tons of CO_2 could be produced in the year 2000. Based on Public Citizen's estimate of the additional renewable energy supplies that will be used in 2000, renewables will displace at least 540 million tons of CO_2, or 8% of the total amount projected to be produced. However, renewables could potentially displace up to 1.2 billion tons, or 19% of the projected amount.

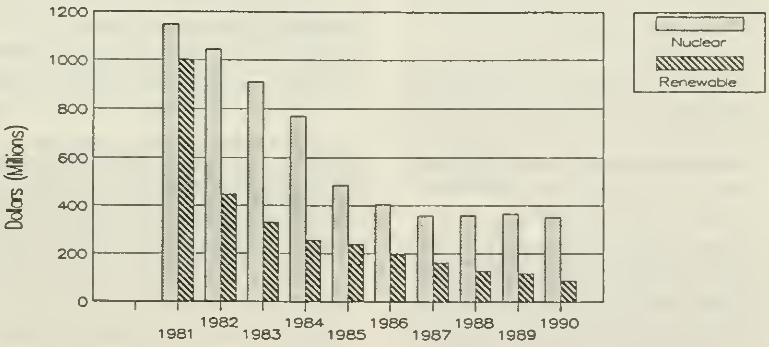
  Additionally, through energy efficiency improvements, a low of 235 million and a high of 2.7 billion tons of CO_2 could be displaced by 2000, depending upon how aggressively efficiency measures are pursued, according to government sources. In the maximum efficiency case, the total 6.4 billion tons of CO_2 emissions could be reduced to 3.7 billion tons. Under this scenario, renewables could displace 15% of the remaining emissions, by Public Citizen's estimate, and potentially up to 32% of emissions if policies supporting renewables are vigorously pursued.

The Reagan and Bush Administrations Have Stalled the Growth of Renewables

- The Reagan Administration cut the R&D budget for renewables by almost 90% over eight years. In constant (1990) dollars, the budget dropped from about $1 billion in fiscal year (FY) 1981 (the last budget of the Carter Administration), to less than $116 million in FY 1989. See **Figure 9.**

- The share of energy R&D spending for renewables dropped from 19% in FY 1981 to 4% in

Figure 9. U.S. Department of Energy Research and Development Budgets for Nuclear Fission and Renewable Energy, 1981 - 1990 (Proposed), In Adjusted, 1990 Dollars.



Data Source: U.S. Department of Energy, Budget History Tables.

FY 1989. For FY 1990, President Reagan's last budget proposed a funding level of $86.5 million, a cut of 25% from FY 1989. This same recommendation was subsequently resubmitted to Congress by President Bush.

- The decision of the Reagan Administration to reorient renewable R&D funds away from commercialization efforts and towards only long-term research has delayed the integration of renewables into the marketplace.

The Reagan and Bush Administrations Have Unwisely Favored Nuclear Power Over Renewables

- For FY 1989, nuclear energy fission and fusion programs (not including nuclear waste research costs and uranium enrichment losses) *each* were allocated about $350 million in comparison to *total* funding for *all* renewable technologies of less than $116 million. Virtually no cuts were proposed for nuclear programs for FY 1990. **Figure 9** (previous page) shows funding levels for nuclear power in the 1980s.

- The potential of renewable energy sources to supply or displace energy, and thus to displace fossil fuel emissions causing global warming and acid rain, is far superior to nuclear power. This is the case for several reasons:

  1) renewables can provide energy in diverse forms, including electricity, direct heat, and liquid and gaseous fuels, while nuclear power provides only electricity;

  2) renewable electric facilities are far less costly than the huge capital investments required for new nuclear power plants;

  3) the lead time for constructing nuclear plants (8 to 15 years) is far longer than for renewable electric technologies, which are often under two years; and

  4) renewable technologies are far safer than nuclear power and pose less significant or no toxic waste disposal problems.

  5) Besides being the least cost-effective way to displace CO_2, nuclear power actually produces up to four times more CO_2 than equivalent electricity production by renewable energy options when energy used in mining and preparing uranium fuel is considered, according to a recent study by Friends of the Earth-U.K.

The Policies of the Reagan Administration Have Reduced the U.S.' Share of the World Market For Renewable Technologies.

- The U.S. share of the world photovoltaic (PV) market declined from 75% in 1980 to 32% in 1988, at the same time that Japan's share increased from 15% to 37%.

- For wind turbines, the U.S. share of the non-U.S. world market was 27% in 1983 but dropped to only 5% in 1987.

- While the U.S. spends approximately $1 million annually on export promotion for the renewable trade industries, the European Community (EC) spends over five times that amount on photovoltaic export promotion alone.

- The EC is also directing $30 million for PV and wind-powered water pumping in its African Development programs, which is almost as much as the entire U.S. R&D program for PVs.

3. Summary of Recommendations

The growth of renewables by 2000 could be much greater than Public Citizen's conservative estimate above, given a more favorable climate for development, which would include the adoption of some or all of the following policies:

1. The federal government should operate its energy policy on the basis of least-cost energy planning which incorporates the full social/environmental costs into each energy option. Utilities should be encouraged to meet new capacity requirements and to replace old, polluting plants with renewable electric facilities.

2. The Public Utility Regulatory Policies Act (PURPA) should be preserved and strengthened as a tool to promote renewable energy technologies and energy efficiency. The Federal Energy Regulatory Commission (FERC) should not move ahead with its plan to radically alter the intent of PURPA, which was passed by Congress in 1978 as a means of encouraging renewable electric facilities and efficient fossil fuel cogenerators. The FERC should not encourage competitive bidding between independent power producers without ensuring that the environmental and other non-price benefits of renewables and energy efficiency will be accounted for in the process.

3. PURPA should be amended to correct specific flaws. These include:

a) the promotion of fossil-fueled cogenerators to the detriment of renewable-fueled electric supplies;
b) the inability of energy conservation programs to qualify under PURPA;
c) the lack of clear guidelines of the obligation of utilities to wheel power between third parties;
d) the small size limit of renewable facilities to quality under PURPA; and
e) the 25% non-renewable fuel limit which can prevent the usage of natural gas to improve the reliability and cost-competitivesness of some renewable technologies.

4. Congress should direct limited federal dollars in the Department of Energy's research and development budget to be spent in favor of the most promising technologies for displacing fossil fuels. Renewables and energy efficiency have far greater potential than nuclear power for this purpose. Renewables should be funded minimally at 1985 levels ($263 million in 1990 dollars).

5. The Department of Energy (DOE) budgets for renewables and energy efficiency should be geared towards the short-term commercialization of existing technologies as well as longer-term research. The three major hurdles that DOE research efforts can help renewables (especially solar and wind) overcome to become an accepted source of power for utilities are high front-end costs, integrating intermittent energy sources with the rest of the power supply, and demonstrating reliability and long-term performance. For the longer-term, developing cost-effective energy storage methods will be necessary in order to displace a significant percentage of conventional fuels.

6. Congress should encourage the growth of renewable energy in developing countries. This would include increasing the budget for the Committee on Renewable Energy, Commerce and Trade (CORECT), and directing the Agency for International Development and multilateral banks to promote renewable energy projects.

4. Conclusion

Public Citizen's overall finding in this report is that renewable energy industries have survived President Reagan's dismantling of government support for renewables, and may even meet President Carter's call for a 20 percent solar society by year 2000 despite huge cuts in spending for research and development.

The contribution of renewables by 2000 could be much greater, however, given a more favorable climate for development.

A 1988 Gallup poll revealed that fully 54% of the American public favors emphasizing the development of solar energy before all other energy supplies to meet future energy needs. Only 12% supported the development of nuclear power first. The poll also shows that half of the public would rather use energy more efficiently than produce more energy.

Yet, in the last eight years, the Reagan Administration and Congress have largely ignored renewable energy and energy efficiency, allowing their research and development budgets to be slashed.

In spite of these and other short-sighted government policies, renewable energy technologies have made major gains within the past decade, although their full potential has been barely tapped. Most renewable technologies are today competitive or near-competitive with new conventional facilities, and they are poised and ready for significant growth.

Combined with improving energy efficiency--an indispensable element of any energy policy--renewables offer a realistic option for greatly reducing fossil fuel emissions within the next five to ten years--a time frame which is critical if climate change is to be mitigated.

The fact that most renewable technologies are today or will soon be competitive with new sources of conventional power demonstrates the potential payback of reorienting Department of Energy (DOE) research and development programs towards near-term efforts to more fully integrate renewables into the marketplace. Congress should set priorities for limited federal dollars in the DOE's R&D budget in favor of renewables and energy efficiency.

To further promote the development of renewables, the government should shape its energy policy according to least-cost energy planning principles, where the energy options with the least overall costs to society are promoted the most. Additionally, the Public Utility Regulatory Policles Act (PURPA) should be preserved and strengthened as a tool to promote renewable energy technologies. (Current proposals of the Federal Energy Regulatory Commission threaten to undermine the primary purpose of PURPA). PURPA should be amended to correct specific flaws so that it more logically promotes renewable-fueled electric supplies. Finally, Congress should encourage the growth of renewable energy in developing countries.

The extent of the near-term contribution of renewable energy to U.S.--as well as global--energy supplies will largely be determined by the extent to which Americans are successful in directing their elected representatives to foster the growth of renewables. This will determine whether renewable energy supplies will grow incrementally by the sheer force of their market competitiveness, or whether policies will be developed now to recognize their inherent environmental benefits as well, and allow them to realize more rapid development.

President Bush and members of the U.S. Congress, who were elected in part because of their stated concern for the environment, will face no greater test of that concern than the policies they support to address the critical challenge posed by climate change and other energy-related problems.

If the fossil fuels that currently threaten the life-sustaining capability of this planet are to be quickly displaced, business-as-usual will not be acceptable.

Table 1. Current and Projected Domestic Renewable Energy Supplies (Quads)

SOURCE	1988	ADDITIONAL	2000
Biomass	3.50	4.50	8.00
Geothermal	0.214	0.266	0.48
Hydro	2.29/3.08 [2]	0.62 [3]	3.70 [4]
Photovoltaics	0.0003	0.021	0.021
Solar Buildings	0.052	1.708	1.76
Solar Thermal	0.005	0.022	0.027
Wind	0.018	0.082	0.10
Total	6.08/6.87 [2]	7.219	14.09

Notes On Appendix Table 1

[1] One quad refers to one quadrillion (10^{15}) British thermal units (Btu). The U.S. currently consumes approximately 83 quads. Electricity production (kWh) figures for solar thermal, wind, photovoltaics, and geothermal figure sources were converted into quads of primary energy displaced using the Department of Energy's monthly Energy Review (Oct. 1988, Table A-9) heat rate conversion figure for electricity (10,261 Btu/kWh). Figures therefore reflect the quads of primary fossil fuel energy displaced by each source.

[2] Note that 1988 was a low year for hydropower. The average annual generation for existing hydro capacity is about 3.08 quads, which would boost the total contribution of renewable energy in an average year for hydro to 6.87 quads. Also note that this is domestic production of hydropower. The U.S. also imports electricity from Canada that is generated from hydroelectric plants. In 1988, the U.S. imported 0.3 quads of Canadian hydropower, so that total use of hydropower in the U.S. that year was 2.59 quads.

[3] This is the approximate amount of energy that would be generated in an average year by the additional 18,000 MW of hydro capacity projected to be on line by 2000.

[4] This is the amount of energy that would be produced by the total hydro capacity in an average year.

Table 2. U.S. Renewable Energy-Based Electric Capacity: Past, Present and Future

Resource	# MW 1980	# MW 1989	# MW 2000	Additional # MW*
Biomass	200	5,154	10,000	4,846
Geothermal	909	2,657	6,000	3,343
Photovoltaics	0	30	1,000	970
Solar Thermal	0	202	1,000	798
Wind	0	1,500	6,000	4,500
Non-Hydro Total	1,109	9,543	24,000	14,457
Hydro	63,300	70,800	80,000	9,200
Pumped Hydro	12,900	17,100	25,000	7,900
Hydro Total	76,200	87,900	105,000	17,100
Total Renewable Electric Capacity	77,309	97,443	129,000	31,557

*Projected capacity for the year 2000 minus current capacity

Source: Public Citizen, based on government and industry data

Table 3. Energy Contribution Potential of Renewables in 2010

Technology	Quads
Biofuels	19
Geothermal	21
Hydroelectric*	3
Ocean Thermal	5
Photovoltaics	13
Solar Buildings	10
Solar Thermal	10
Wind	9
Total	90

**Additional* energy from small hydroelectric capacity.
Source: U.S. Department of Energy, Energy Research Advisory Board.

Table 4. Past, Current and Projected Electricity Production Costs of Newly Constructed Renewable Electric Technologies (in 1989 constant dollars).

	Cost--Cents/kWh		
Electric Technology	1980	1989	1995/2000
Biomass	5	5	5
Geothermal (high-temperature hydrothermal resource)	4 - 8	4.5 - 5.5	4 - 6
Hydroelectric	n/a	3 - 6	3 - 6
Photovoltaics	150	20 - 40	6 - 18
Solar Thermal (Luz parabolic trough)	24	8 - 12	5
Wind Power	25	7 - 9	4 - 5

Note also that solar building technologies are competitive as a means of displacing the need for electricity and other conventional energy sources for heating, cooling and lighting.

All figures are levelized, life-cycle costs, and were calculated separately for each technology by different sources.
Source: Public Citizen, based on government and industry data. See cost subsection of each technology section.

Table 5. Cost of Electricity from New Conventional Power Sources (In constant, 1985 dollars).

Baseload Technology	Cost (c/kWh)
Conventional Pulverized Coal	6.3
Natural Gas Combined Cycle	4.4
Peakload Technology	
Combustion Turbine (gas or oil)	6.4 - 9.1

Source: Electric Power Research Institute.

STATEMENT OF
HERBERT M. BOYD
ALABAMA POWER COMPANY

SUBMITTED TO THE
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
OF THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

JUNE 15, 1989

Mr. Chairman, members of the Subcommittee, I am pleased to have this opportunity to present the views of the Alabama Power Company on S. 488, the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989.

I am Herbert M. Boyd, Director-Technology Management at Alabama Power Company, a subsidiary of The Southern Company.

The electric utility industry will be seeking new sources of energy by the mid-1990s and renewable energy technologies should be available for consideration at that time to help meet the United States' energy independence goal. We believe that one of the renewable energy technologies that offers great promise as a source of clean energy for the utility industry is photovoltaics. This belief is demonstrated by Alabama Power Company building and placing into operation the world's largest amorphous silicon thin-film photovoltaic grid connected array. This 75 KW demonstration unit is now producing enough power at the time of our system peak to supply the energy for 19 homes.

In addition to the $1 million spent on the above installation, Southern Investment Group, another subsidiary of The Southern Company, has invested $6.1 million in a joint venture with Chronar Corporation to build and put into operation a 1MW amorphous silicon photovoltaic cell manufacturing facility in Birmingham, Alabama.

The United States is in a race with Japan, West Germany and other countries in the development of photovoltaics for central power applications by utilities. The winner of this race with the best technology and lowest cost will have a worldwide market for their products. The U.S. utility industry does not want to import the photovoltaic products needed to meet the energy demands of the 1990s.

The world photovoltaic markets, of which the U.S. once held an 80% share, are expected to grow into a $1 billion a year market by the year 2000. America's market share has fallen to 31% as our R&D expenditures have fallen behind those of Japan and Germany whose R&D expenditures and market shares have risen. If we support research in these technologies, we can develop and sell them to the world; if we don't, then we will buy them from others. The photovoltaic industry can have a significant positive effect on our technological competitiveness and our balance of payments. Now is the time to reemphasize R&D.

Since 1981 amorphous silicon thin-film photovoltaics have increased its market share from 3% of world sales of 5MW to above 40% of 34MW in 1988. We believe that amorphous thin-films offer potential for power applications in the utility industry and is the photovoltaic technology we are currently investigating. During the past year, with help from Department of Energy funding, efficiencies of more than 14% have been achieved with new thin-film materials. However, as methods are found to increase efficiencies in the laboratory, additional research and funds are needed to use these new materials in low-cost, reliable, large area submodules. This work needs to be done in the United States and not in Japan and West Germany.

The Southern electric system continues to feel that fundamental materials research will eventually advance the photovoltaic state-of-the-art further than any of the other areas of current investigation. Until the industry

CAN UNDERSTAND WHY MATERIALS BEHAVE AS THEY DO, SOLUTIONS CAN NOT BE THEORIZED OR DEVELOPED TO SOLVE MANUFACTURING PROBLEMS ASSOCIATED WITH THIN-FILM PHOTOVOLTAIC CELLS. SINCE COST IS A SIGNIFICANT DRIVER IN ALL MANUFACTURED PRODUCTS, BASIC MATERIALS RESEARCH IS NEEDED TO MAKE THESE IMPROVEMENTS IN STRUCTURE AS WELL AS MANUFACTURING. IN ADDITION, THE INDUSTRY MUST STRIVE TO DEVELOP NEW MATERIALS WHICH HAVE THE CAPABILITY OF INCREASING EFFICIENCY SO THAT THE COST GOALS REQUIRED TO BE COMPETITIVE WITH EXISTING ENERGY FORMS CAM BE ACHIEVED.

THE SOUTHERN ELECTRIC SYSTEM HAS ALWAYS SUPPORTED LONG-TERM STABLE ENVIRONMENTS FOR RESEARCH AND DEVELOPMENT ACTIVITIES IN RENEWABLE ENERGY TECHNOLOGIES. WE HAVE, OVER THE LAST FOUR YEARS, CONTINUED TO MAKE STATEMENTS BEFORE CONGRESS SUPPORTING THE ESTABLISHMENT OF LONG-TERM GOALS AND MULTI-YEAR FUNDING LEVELS. WE HAVE, THROUGH OUR OWN EFFORTS, SUPPORTED NEW INITIATIVES WHICH HAVE HASTENED THE COMMERCIALIZATION OF THE PHOTOVOLTAIC TECHNOLOGIES. WE HAVE, THROUGH CONTRACTUAL AGREEMENTS, COLLABORATED WITH FIRMS IN THE PHOTOVOLTAIC INDUSTRY TO ENCOURAGE THOSE INDUSTRIES TO MONETARILY SUPPORT NEW RESEARCH FOR BOTH TECHNOLOGY AND PRODUCTION CAPACITY.

THE SOUTHERN ELECTRIC SYSTEM CONTINUES TO EVALUATE RESOURCES FOR MEETING ITS CUSTOMER'S NEEDS IN THE MOST ECONOMIC FASHION. WHILE WE HAVE IDENTIFIED THAT PHOTOVOLTAICS AND SOLAR ENERGY TECHNOLOGIES IN GENERAL HAVE THE POTENTIAL TO MEET A PORTION OF OUR FUTURE GENERATION REQUIREMENTS, THE RELIABILITY AND ECONOMICS OF THESE TECHNOLOGIES MUST BE PROVEN IN ORDER FOR THE ELECTRIC UTILITY INDUSTRY TO ADOPT SUCH TECHNOLOGIES AS ONE OF ITS MAIN ENERGY RESOURCES.

S. 488 ADDRESSES THESE ISSUES AND THIS SUBCOMMITTEE IS TO BE COMMENDED FOR FOSTERING THIS LEGISLATION WHICH WILL SUPPORT VITAL RESEARCH NECESSARY TO PROVE THE WORTH OF THESE TECHNOLOGIES IN MEETING THE COUNTRY'S FUTURE ENERGY REQUIREMENTS. THE SOUTHERN ELECTRIC SYSTEM WILL CONTINUE ITS EFFORTS TO PROVIDE ITS CUSTOMERS WITH RELIABLE ENERGY AT THE LOWEST COST POSSIBLE.

TESTIMONY ON
ENERGY EFFICIENT INDUSTRIALIZED HOUSING RESEARCH

by

Dr. John T. Moseley

Vice President for Research

University of Oregon

and

Dr. David L. Block

Director, Florida Solar Energy Center

Submitted to

U.S. Senate

Committee on Energy and Natural Resources

Subcommittee on Energy Research & Development

We would like to begin by thanking the Subcommittee for this opportunity to state the views of the University of Oregon and the Florida Solar Energy Center on the importance of energy efficiency research in industrialized housing. Industrialized houses have a portion built at a location other than where it is ultimately sited. Our testimony strongly supports S. 488 and stresses the importance of multi-year funding for energy efficient industrialized housing research. Establishing a first-rate research program without assurance of multi-year funding is very difficult.

The Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989 (S. 488) would provide multi-year authorizations for factory-made housing research and development and joint venture support, along with authorization for solar and energy conservation research programs. The legislation is important to us because it lays out a strong research foundation for a five-year energy conservation research program in industrialized housing.

The Department of Energy began funding a five-year research program in fiscal year 1989 to improve energy efficiency in industrialized housing. The University of Oregon and the Florida Solar Energy Center are the two lead centers funded by DOE. The general approach of the program is to review U.S. industrialized housing products and processes as a way to encourage the adoption of more efficient technologies. This requires working with the building industries to research and develop new design techniques, building technologies and manufacturing processes.

An important element in this research approach is the assumption that the program will be successful only if its results are of use to the industrialized housing industry and can be easily incorporated by them. To ensure this outcome, the program has a steering committee comprising such representatives of the housing industry as Kingsberry Homes, Acorn Structures, Penn Lyon Homes, The Charles Wayne Group, Weyerhaeuser, BBH Enterprises, General Electric, Fleetwood Enterprises, Ryland Group, and Automated Builder Magazine. The committee also has members from power suppliers such as the Bonneville Power Administration and Florida Power and Light, policy groups such as the Northwest Power Planning Council, and other researchers knowledgeable in industrialized housing. S. 488 provides financial assistance for a joint venture with such specialized private firms. Because the building industry is diverse and the U.S. industrialized housing industry is in its relative infancy, we believe it is important for the federal government to fund energy conservation research that will have immediate and long term effects. By our estimates, industrialized housing can be built at minimal costs to improve its energy efficiency by 30 to 60% by employing changes in the design, fabrication and erection process.

By decreasing fossil energy consumption, we will slow global climate change. The Office of Technology Assessment stated the U.S should "promote energy efficiency in all sectors" to decrease greenhouse gas emissions and acid rain. The World Resources Institute has also stressed slowing the growth of greenhouse gases with energy efficiency: "Using less energy to provide the same end use services reduces global warming through a reduction in carbon dioxide emissions...More efficient heating, lighting and air conditioning of new buildings especially in the residential and commercial sector can have a dramatic effect on CO_2 emissions." Improving efficiency is the fastest and least-cost strategy for reducing CO_2 emissions. Studies have shown that the average residential home in Florida will produce 12 tons of CO_2 annually by its use of electricity.

The goal of the current industrialized housing research program is to conduct research that will develop more energy efficient and economic housing. This requires developing new technologies, industrial processes, and design techniques that can be easily implemented by the housing industry to build new homes. This goal will be reached by pursuing three major areas of investigation.

1. **Improving the design, construction, and materials and component installation of industrialized housing.** The quality of design is important to assure market acceptance. Improving construction practices and component installation is important because building components that would normally save energy may not perform efficiently if they are constructed or installed incorrectly. For example, low-E windows that are improperly installed allow air to escape around the sash.

We are improving construction practices by developing test sites at the University of Oregon and the Florida Solar Energy Center. As successful prototypes are developed we will evaluate them in a wide range of settings including urban, suburban, and rural locations. These tests will also address a range of housing issues. The tests are important to demonstrate the validity of energy conserving industrialized housing in real world settings.

2. **Improving the industrialized process used by the housing industry.** Currently, industrialized housing in the U.S. is simply site-built housing constructed under a roof to protect it from the elements. None of the

potential efficiencies possible with a sequenced fabrication process are being used. The Office of Technology Assessment pointed out that advanced "manufacturing technologies, including a variety of numerically controlled production systems, which have been developed for other manufacturing industries... could be adapted for use in factory and field housing construction."

Unlike other industries, the factory processes used to build homes are variations on conventional styles and techniques without much "studied" innovation. For example, the automobile industry constantly looks for new techniques and processes to design and build its products. It spends a great deal on research to determine what innovations can be incorporated into new models and what the costs will be. The home building industry is not committed to discovering new processes and spends very little money on research.

Our preliminary investigation of foreign industrialized housing indicates that computer use for both design and production exceeds that in the U.S. No documentation of computer use in U.S. industrialized housing exists and there are no computerized energy analysis tools designed specifically for industrialized housing producers. We are surveying computer use and analyzing the energy decision-making process in housing industrialization to determine the specifications for new energy design tools that will complement the increased levels of computerization we expect in the U.S. industry.

3. **Working with the buildings industry on research that otherwise would not be attempted.** An Office of Technology Assessment study found that responsibility for housing research falls to the federal government because even the largest housing firms do not conduct basic research. The positive response of the Steering Committee has shown that industry is interested in pursuing joint research activities.

Because many energy conservation strategies are related to climatic needs and many industrialization strategies are affected by regulations, labor, markets, etc., we are investigating linkages between regional industrialization techniques that have evolved independent of energy consideration and energy conservation strategies developed in the same region. For example, we are working with Weyerhaeuser to incorporate radiant barriers in roofing products that will greatly reduce air conditioning energy use.

The trend toward more factory-built housing has accelerated in the past 20 years. Most houses built today have factory-made windows, roof trusses, and kitchen cabinets, and panelized construction is becoming a common practice. The trend to industrialization seems certain to continue. By the 1980's there were more that 1000 home manufacturers operating in the U.S. Another 2000 or more companies mass-produced components for houses, such as floor, wall and roof sections. Today, most large homebuilders primarily build industrialized housing. Factory-built homes can be made faster, better, and at lower cost, and are protected from weather delays by a factory roof.

A factory-built house can also save the buyer on average 10% of the cost of a conventional house. The benefits of more efficient organization, better financial backing and corporate marketing techniques are as important as new technologies. If additional conservation measures can be added to the production and erection processes and to the operation of the house, the owner will save additional purchase and operating costs. If one accepts these arguments, industrialized housing is inevitable in the 21st century.

A few barriers to innovation in the factory-built housing industry, however, have been alluded to. For example, interest in factory-built housing has been limited because many consumers and builders in the U.S. associate factory production with low-cost, low-quality housing units. This barrier does not exist in countries such as Japan and Sweden where factory construction has been marketed successfully because it is associated with reliability, high quality, and advanced production techniques.

Another barrier is caused by wide swings in the U.S. demand for housing that make it difficult for home builders to justify making large capital investments. In addition, most U.S. home builders are too small to make the capital and engineering investments necessary to automate production.

Finally, the industry is so fragmented and diverse that little research is conducted to improve the technology of either the structures produced or the manufacturing process. And before the DOE industrialized housing project was funded, government support of construction related research was virtually nonexistent.

Some of the barriers to factory-built home building innovation, however, can be affected by federal involvement. These include building standards and guidelines, and research that documents the cost and energy efficiency advantages of factory-built housing.

The second major area where U.S. barriers could be reduced is by providing data about the economic and energy advantages of using factory-built construction.

Housing may soon face competition from abroad. Ten foreign home builders are importing housing into the U.S. An increase in the importation of foreign housing and housing products could occur. It is more likely that foreign firms may try to enter into joint ventures with U.S. firms and export their advanced technology to the U.S.

Japanese application of advanced technology has resulted in innovations in single-family industrialized housing construction. Sweden, Japan, Finland, and Denmark have also made commitments to factory-crafted, energy-efficient, affordable housing. All have been so successful that foreign manufactured housing could pose a serious threat to both the domestic housing construction and wood products industries.

Foreign governments and industry spend more on housing research and development than the U.S. This enables the housing industries in foreign countries to develop innovations more quickly and more completely.

In contrary, now is the time for the U.S. housing industry to develop new and innovative methods of manufacture and design that will produce a product equal to or better than that produced by foreign housing manufacturers. We must begin with research on energy efficient industrialized housing technologies. A strong federal program is the important first step. Support of S. 488 is the second step. We encourage Congress to take these steps.

RlW:ml78

ARI AIR-CONDITIONING
& REFRIGERATION
INSTITUTE

Representing Manufacturers
of Heating, Ventilating,
Air-Conditioning and
Refrigeration Products

March 30, 1989 Ben Cooper

The Honorable Wendell H. Ford
Chairman, Subcommittee on Energy
Research and Development
Committee on Energy and Natural Resources
U.S. Senate
SH-312 Hart Senate Office Bldg.
Washington, D.C. 20510

Dear Mr. Chairman:

The Air-Conditioning and Refrigeration Institute (ARI) is a national trade association representing manufacturers of over 90 percent of the U.S. made central air conditioning and refrigeration systems. ARI wishes to present its comments on the U.S. Department of Energy (DOE) Fiscal 1990 Budget request for the Buildings and Community Systems budget, particularly in the area of technology and consumer products. We ask that these comments be included in the Subcommittee's hearing record on the DOE conservation budget.

Our near-term interest in this program area relates to its involvement in the development of non-ozone-depleting and energy-efficient refrigerants. As you are aware, the Montreal Protocol for Substances that Deplete the Ozone Layer requires that the U.S. consumption of chlorofluorocarbons be reduced by 50 percent by the year 1998. Our members manufacture air conditioning chillers, commercial refrigeration equipment, mobile refrigerated transport equipment, drinking water coolers, and automatic commercial ice makers, all of which rely in one form or another on CFC refrigerants. Our members as well as chemical producers are actively attempting to develop alternative refrigerants and the equipment that can use them. There is a significant federal role in this area as it relates to ozone protection and energy efficiency.

In order to fully address the issue of the development of non CFC refrigerants in a timely fashion, our industry has developed a multi-year research and technology plan which addresses not only alternative refrigerants but the areas of energy efficiency and building environment as well. A copy of this plan is attached. We ask that it be included in the record.

We believe there is a considerable role for federal research in the transition to non-CFC refrigerants. The process to develop safe non CFC refrigerants and related equipment is a multi-step process beginning with scientific research on substitute refrigerants and ending with commercial production of equipment relying on them. There is a useful federal research role in the early stages of this process particularly in developing the thermodynamic and thermophysical property data on various alternative refrigerants and also in the materials compatibility testing of alternative refrigerants. DOE's role in the development of environmentally-safe refrigerants is now extremely important from a national policy standpoint because of the impact of potential new refrigerants on energy efficiency. The following areas are recommended for DOE research funding at a level of $10-12 million per year for five years.

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PROPERTY DATA

There has been speculation recently that a solution to the CFC problem now exists. Much discussion has occurred regarding potential substitutes for CFC-11 and CFC-12, namely with the development of HCFC-123 as a replacement for CFC-11 and FC-134a as a replacement for CFC-12. The performance characteristics of the substitute refrigerants and preliminary toxicity tests indicate that they could be acceptable substitutes. However, comprehensive research on these as well as other substitutes is not yet complete. While the chemical producers have developed some of the critical property and performance data on 123 and 134a they have not produced complete data sets on these or on other potential replacement refrigerants. Therefore, DOE and the National Institute of Standards and Technology (NIST) have funded modest research projects to expand this information. There are several possible substitute refrigerants as well as refrigerant mixtures which offer some promise in terms of their energy efficiency and thermal characteristics. Yet, important property data on these substitutes is not complete. As it happens, the research capabilities of NIST and the personnel associated with them provide some of the most competent resources available in this country for this work. We support this work and urge the Subcommittee to increase the DOE and NIST funding for it so that several other possible substitute refrigerants can be researched simultaneously and quickly.

The reason for accelerating this work has to do with some problems that have already occurred with the substitutes 123 and 134a. While their toxicity may be acceptable and their performance characteristics seem similar to CFC-11 and -12, problems have been revealed with both. In the case of 134a, its energy efficiency is lower than CFC-12 and it also has the added problem of not yet having a suitable lubricant found to work with it in most compressors. Tests of 134a with potential lubricants in DOE's Oak Ridge National Laboratory (ORNL) have indicated an energy efficiency degradation of 20 percent or more. This obviously is not acceptable to the consumers of these products nor to the energy policy officials of the United States. In addition, with respect to 123, it has been found to attack materials within existing systems such as seals. It is also less efficient than CFC-11. Industry and government researchers have concluded that a broader search for replacement refrigerants is warranted.

PERFORMANCE TESTING

Research into the performance characteristics of alternative refrigerants must continue at an accelerated pace. It was the test work done by ORNL which provided the information on the efficiency reductions associated with 134a. This type of bread board scale performance research must also continue on this array of substitute refrigerants including near- and non-azeotropic mixtures. This work may actually involve the use of university laboratories as well as federal facilities to simultaneously research sufficient numbers of refrigerants.

MATERIALS COMPATIBILITY

Alternative refrigerants have to be tested to determine their impact on materials within the equipment. In addition, each specific alternative refrigerant must be tested with potential lubricants, and we must determine how those combinations of refrigerants and lubricants affect materials. Our industry has determined that in order for this research to be done rapidly on the various alternative refrigerants simultaneous, coordinated testing must occur in company laboratories, federal facilities and in university or private research centers.

In order for this work to go on and be useful to industry test methodologies must be standardized so that all research information is usable. Our members are committed to providing information and advice on such methodologies to NIST, which must help develop standardized test methodology. ARI has agreed to furnish $50,000 to NIST for this work and for other refrigerant data projects. We have also obtained agreement from major manufacturers within our organization to provide refrigerant research information they possess to a central data bank in NIST. DOE funding should be made available to help support NIST refrigerant activity as needed.

While NIST can provide assistance in the development of usable test methodology, the actual testing might best be accomplished in a combination of industry, private, and university laboratories. Experts from ARI member companies are developing a materials and lubricant compatibility research plan for this purpose. ARI recommends that $2 million be appropriated annually for this purpose. This program might best be managed by ARI with DOE oversight.

INFORMATION GATHERING

DOE efforts to monitor the technology development in other countries must continue and be expanded to provide a more workable information transfer to industry. These research projects should be part of a multi-year government-industry partnership to develop the best technological solutions. Our industry is already working closely with DOE in this area and hopes to continue.

INSTALLED EQUIPMENT

We must keep in mind the vast inventory of installed equipment which will continue to need servicing with either new or recycled CFC refrigerants until replaced. Many years will be required to replace all of it. Some in the industry believe we may find substitute refrigerants suitable as "drop-ins" for some of these units. We don't have proven drop-ins yet, and we may not ever have them for some of this installed equipment. It is likely that small quantities of CFCs will continue to be needed beyond the year 2000 to keep installed equipment operating.

Industry is working hard and will be heavily engaged for the next few years in finding refrigerants for new equipment and getting that equipment into production. Refrigerants being developed for new equipment designs will not necessarily work in current equipment. Government research is needed to expedite the search for substitute refrigerants for the installed inventory. We believe that DOE should significantly expand its limited refrigerant research program to meet this need and should be provided with adequate funds to do so. The objective should be to identify and then test promising substitute refrigerants, including new blends, in currently installed equipment. This testing could be done in U.S. government facilities. NIST can assist by identifying the refrigerants to test, based on measurements and analysis. It is clearly in the public interest to find ways of reducing the dependence of equipment operators on CFC refrigerants while keeping this essential machinery operating until it is eventually replaced.

Clearly, the major steps in the process of developing alternative refrigerants and putting them to use in new equipment could be accomplished by chemical producers and equipment manufacturers given a reasonable timeframe. However, if the CFC phaseout schedule in the Montreal Protocol is changed to accomplish a phaseout by the year 2000, we cannot meet the challenge without federal support. We urge your Subcommittee to give emphasis to this effort and to recommend adequate funding. We believe it should have high priority.

Sincerely,

Arnold W Braswell

Arnold W. Braswell
President

Enclosure

cc: The Honorable Pete V. Domenici, Ranking Minority Member

ARI RESEARCH AND TECHNOLOGY PLAN

Revised 2/6/89

Research and Technology Plan Task Force Members

Joseph Glas	du Pont de Nemours, Inc.
Dieter Grether	LSB Industries
David Goldberg	Standard Refrigeration
Kenneth Hickman	York International
Fred Honnold	Carrier Corporation
Robert Johnson	Lennox Industries
Dean Ruwe	Copeland Corporation
James Schultz (Chairman)	The Trane Company

OVERVIEW

In May 1988, ARI's Board of Directors determined that the association should play a greater role in identifying, coordinating, and influencing pre-competitive research projects relevant to the industry. In order for the U.S. air conditioning and refrigeration industry to remain competitive in the world market, increasing attention must be paid to pre-competitive research which will result in the development of more advanced, technologically competitive industry products.

In order to play a role in the research process, the Research and Technology Plan Task Force has prepared a Research and Technology Plan which will serve as a framework for ARI's research and technology initiative.

The plan serves three main purposes:

1. **To define, focus, and coordinate industry pre-competitive research on key technologies which will accelerate the development of products in a globally competitive environment;**
2. **To facilitate work with government agencies to secure funding for research on these technologies; and**
3. **To serve as a reference for members in planning their company research and development programs.**

By presenting a common plan for pre-competitive research, with a united voice, the industry stands a much better chance of having an impact on the direction of such research.

The Task Force has grouped potential areas of research into three broad areas:

They are:

1. **Refrigerants**
2. **Energy**
3. **Building Environment**

For each area the Task Force has outlined a goal or goals, an objective, and specific pre-competitive research projects which it recommends be carried out. The plan sets forth the general concepts for the direction of research. When carried out as part of a coherent plan, they will advance the needs of the industry, potentially resulting in more competitive products which can meet the challenge of foreign competition. By carrying out the program of research which is put forward, the air conditioning and refrigeration industry can also contribute to the broader national objectives of decreasing energy consumption, and providing equipment which safeguards the environment and human safety and well-being.

ARI hopes to achieve several objectives by presenting an ARI list of research priorities to the government. First, ARI will try to get the federal government and laboratories to follow ARI's research priority list in terms of the importance and timing of research. Second, where the government or others are not conducting research which ARI thinks is important, ARI will work to have that research done. ARI will also try to get additional monies for research which members believe is necessary. Third, ARI can also play a role in steering the government away from projects or research focuses which industry does not believe will yield fruitful results. Finally, ARI can play a useful role in developing a coherent plan for government research to avoid waste and duplication of effort.

This report outlines the areas of potential research which the Research and Technology Plan Task Force perceives to be priority areas. It serves as an overview of what ARI seeks to accomplish. Recommendations on specific funding levels and allocation of work are not included, but will be addressed as the Research and Technology program evolves.

The research projects put forth in this plan document been initially prioritized. Clearly, not all of the projects can be given an equal level of attention. Work on CFC alternatives is a clear, immediate priority. For some projects listed in the plan, longer-term, small-scale research, perhaps by universities, may be more appropriate. Revisions to the priorities will be made as required.

The appendix lists projects of Oak Ridge National Laboratory, the Electric Power Research Institute and the National Institute of Standards and Technology and provides a breakdown of FY 1988 government budget allocations for industry research.

RESEARCH AREAS

I. REFRIGERANTS

There is no question that immediate research on substitute refrigerants, beyond that which is already under way, is required on alternatives to the CFC compounds that may be banned as a result of the Montreal Protocol.

ARI's goals for refrigerant research are:

1. **To achieve equal or better energy efficiency in HVACR equipment;**
2. **To use environmentally sound refrigerant substitutes;**
3. **To assure prompt action in all use sectors in light of the time-frame for CFC phase-out;**
4. **To protect the safety of industry personnel; and**
5. **To protect the stratospheric ozone layer.**

ARI's objective in the refrigerant research area is to facilitate and expedite the industry's transition from CFC refrigerants to acceptable alternative refrigerants. Of utmost importance will be the need to ensure compatibility between new refrigerants and materials, including lubricants.

A. REFRIGERANT RESEARCH UNDER WAY

Two non-ozone-depleting refrigerants have been identified as the principal candidates to replace specific CFC compounds. These are FC-134A for R-12, and HCFC-123 for R-11. Research is required to evaluate the toxicity, thermodynamic properties, transport properties, and chemical compatibility with materials required in refrigeration equipment. Toxicity research is under way for these two compounds under the aegis of an international consortium.

The National Institute of Standards and Technology (NIST) is determining thermodynamic properties of FC-134A, HCFC-123, and 141B. Material compatibility testing for these alternatives is under way on a proprietary basis in a number of manufacturing companies, in partnership with producers. NIST is planning to do testing on transport properties.

There are mixtures and additional fluids potentially suitable as refrigerants, some of them flammable. Examples are R-32, 124, 125, 134, 143A, R-22/152A, R-22/142B, R-32/124, and R32/125.

B. PROPOSED REFRIGERANT RESEARCH PROJECTS

The Task Force believes that many research tasks must be carried out concurrently if our industry is to have viable alternative refrigerants which can be used in HVACR equipment without diminishing their efficiency or durability. These research tasks are outlined below.

1. Define the properties, operating parameters, and application potential of the following refrigerants, in order of priority:

- 134/134A as a substitute for 12
- 123 as a substitute for 11
- 125 as a substitute for 502
- 124 as a substitute for 114
- 32 and 143A as substitutes for 502
- chemical blends

2. Determine material compatibility with alternative refrigerants and with such things as lubricants, elastomers, gasketing, motor insulation, metals, filter driers, and components.

3. Investigate containment and recovery/recycling of major CFC refrigerants including development of an inexpensive, reliable, analytical device to quickly and cheaply analyze the quality of recovered refrigerants.

4. Investigate disposal methods which are cost effective and ecologically sound.

5. Conduct necessary analysis and screening to identify alternative compounds and chemical blends which are outside the current testing process in order of priority. This review should be conducted with compatibility, containment, recovery/recycling and disposal needs taken into account.

6. Identify candidate lubricants and understand the interaction of various refrigerants or refrigerant mixtures with the lubricants and various materials under typical system operating conditions.

7. Determine thermodynamic properties of the principal candidates. Extend this work as new candidates are found in Task 5 above.

8. Determine transport properties of the principal candidates. Extend this work as new candidates are found in Task 5 above.

9. Research to measure and classify the flammability, toxicity and other potential hazardous characteristics of refrigerants and refrigerant blends as sold and after preferential leakage.

C. REFRIGERANT RESEARCH TIME LINE

To develop the time lines in Appendix A, the following assumptions were made:

1. Dates are the earliest possible for completion of tasks assuming a cooperative industry program.

2. Only single component refrigerants are addressed. Development of azeotropes, and near-azeotropes would be a supplemental program to be defined once promising constitutent refrigerants are identified.

3. Generic test results would be very valuable to the industry if the tests are performed in accordance with industry requirements. Therefore, a prerequisite is to develop consensus requirements for each new refrigerant as a first step.

4. Individual refrigerant research time lines are based on a general time line framework shown as Fig. 1. on page 8. This organizes each program into four phases, as follows:

Phase I:	Establishment of formal industry requirements and a cooperative industry research program.
Phase II:	Short-term testing and evaluation aimed at confirming the refrigerant's practicality and usefulness. Where more than one refrigerant is available as an alternate, this phase would include selection of the primary candidate. Some Phase II projects could be cooperative industry projects.
Phase III:	This phase would commence with the commitment of one or more refrigerant manufacturers to build initial production plants. Initial production plants produce commercial quantities of refrigerants as opposed to test quantities. The work in this phase is a combination of cooperative projects and proprietary projects.
Phase IV:	This phase follows the completion of initial production plants, when refrigerant quantities are large enough to support large scale field testing and pilot runs of equipment.

The basis of the time lines of the refrigerants is as follows:

a. R-134A: We are approaching Phase III. Most of the Phase I and II tasks are complete and the refrigerant manufacturers have committed to pilot production. Major opportunities for industry cooperation include the selection of a lubricant, materials compatability testing, and insuring that the proper specifications for motor winding coatings are established. There is also a place for cooperative effort in the testing of transport and thermodynamic properties. As a potential replacement for R-12, R-134 should be considered as an alternative to R-134A if problems with toxicity of 134A show up unexpectedly.

b. R-123: Most of the Phase I and II tasks are complete, and potential production processes have been defined. Refrigerant manufacturers' commitment to initial plant production is urgently needed to begin Phase III. (We have based the time line of R-123 on getting this commitment in the first quarter of 1989 in order to have initial plant production by the first quarter of 1991.) Major opportunities for industry cooperation include the selection of a lubricant, materials compatibility testing, and insuring that the proper specifications for motor winding coatings are established. There is also a place for cooperative effort in the testing of transport and thermodynamic properties.

c. R-32, R-124, R-125 and R-143A: As potential replacements for R-502 and/or R-114, these refrigerants are relatively unknown. The industry needs to establish a cooperative program for Phase I and II. Phase II would provide enough information to select the best candidate for Phase III and IV.

II. ENERGY

Energy efficiency is central to industry competitiveness. Research in this area should not focus on incremental efficiency improvements in existing equipment, which can be left in the competitive realm. Rather, research should explore breakthrough technologies. Researchers should examine barriers which, if overcome, would result in a quantum leap in product performance.

The goal for energy research is to overcome current technical barriers which prevent manufacturers from obtaining further significant energy consumption reductions in equipment systems and buildings. Reductions in energy consumption would have obvious advantages in terms of national energy policy. Reductions would decrease U.S. use of fossil fuels which contribute to the Greenhouse Effect. It would also cut U.S. reliance on foreign sources of fuel and encourage use of more efficient energy sources.

The target is to find how to further cut energy losses in HVACR systems by 50 percent by the year 2000. Specific energy consumption reductions will, of course, vary by product, but 50 percent is not an unrealistic, nor a technologically infeasible, goal.

The objective of energy research is to investigate new concepts and alternatives for reducing energy usage of HVACR products and systems. Research should be conducted in the following specific areas:

Short-term Research

1. **Motors and Drives**
2. **Fan and Blower Design**
3. **Heat Exchanger Design**
4. **Unit and System Controls**
5. **Compressors**
6. **Materials**

Long-term Research

1. **New Cycles**
2. **Thermal Storage Concepts/Materials**
3. **Heat Transfer and Fluid Flow**
4. **Materials**

Specific recommendations on projects in each of the areas mentioned above follow.

1. Motors and Drives

A. Variable speed drives can reduce energy consumption at part load and varying speed, thereby saving energy on a seasonal basis. Improvements are desired in efficiency, compactness, and cost effectiveness. New types of motors, such as switched reluctance motors, may improve efficiency in variable speed systems. Present barriers are costly power handling components, limited kilowatt throughputs, and cost of components required to reduce power line EMI (electromagnetic interference).

B. Improve efficiency and reduce noise of standard motors used for fans in air-cooled condensers and in air handling equipment. Present barriers are "traditional" technology in design and manufacture of these standard motors.

C. Increase efficiency of motors used in large systems (100 HP and over) with application of superconductivity developments. Present efficiency levels are high; 50% reduction in losses will require a major change such as superconductivity or application of new permanent magnet materials.

2. Fan and Blower Design

A. Increase the efficiency and reduce the noise of fans used in such applications as air-cooled condensers and air handlers. New designs with innovative airfoil shapes may increase efficiency and reduce noise.

Present barriers are traditional design, material selection, and manufacturing methods used by suppliers. Manufacturing methods to economically produce complex blading and flow channels are needed. New designs with new materials may be possible.

B. Review the extremely capable computational programs that are available for analyzing and predicting fluid flows. These programs are used by NASA, jet engine, and aircraft manufacturers. They can determine flows through or around particular geometries, and may be adaptable to design the optimum geometry to produce a desired flow field. Present barriers to use of these programs in the HVACR industry are the large computers required and the skill/training level needed to understand the programs and how to input models. "User friendly" programs and training materials for flow analyses could speed the development of more efficient, quieter air conditioning, heat pump, and refrigeration systems.

C. Elimination of fans and blowers by new convection concepts should be considered. Creative ideas are needed; e.g. electrohydrodynamic pumping of air.

3. Heat Transfer and Fluid Flow

A. There is a need to continue to build fundamental knowledge regarding fluid flow and heat transfer as applied in air conditioning and refrigeration systems. There is also a need for improved theoretical models with applications to practical problems.

1. How evaporation and condensation takes place at the heat transfer interface;

2. Turbulent flow behavior and losses in typical refrigeration heat exchangers and piping;

3. The causes of radical regime changes at high mass flows;

4. How basic geometries affect turbulence and pressure drops;

5. Behavior of nonazeotropic refrigerant mixtures in heat exchangers;

6. Two-phase flow behavior in heat exchangers; e.g., over baffles, or through tube bundles of different geometries;

7. Effects of the presence of lubricants on heat transfer and flow behavior.

The classic engineering models are, at best, simplistic and, at worst, misleading. To be able to reduce energy losses by fifty percent, heat exchangers will have to be made so that they will operate at significantly reduced temperature differentials than those currently on the market. This will entail the development of new heat exchanger designs and their testing with refrigerants and other fluids used by the HVACR industry.

B. The effect of fouling, especially on the development of new heat exchangers is dramatic. Serious work is needed to determine the true effect of fouling on HVACR products, and methods for keeping heat transfer surfaces clean.

The research task should, therefore, develop a better understanding of the level of product deterioration caused by "typical" fouling, and the development of systems to eliminate fouling.

C. Test existing alternate heat exchangers (i.e., electromagnetic, spiral, plate, plate fin, fractal surface, etc.) which are currently being used in other industrial sectors and have not been explored for use within the HVACR industry;

D. Development of compressor designs which are tolerant of liquid, or control systems to eliminate the requirement for superheat at the compressor, would dramatically increase efficiency in evaporators due to the elimination of a requirement for superheating in the evaporator.

E. Development of an oil-free system would undoubtedly increase heat transfer coefficients significantly, and possibly allow the use of surfaces which would be sensitive to the amounts of oil normally found inside air conditioning systems.

F. Investigate new composite materials to provide higher heat transfer coefficients than current materials.

G. Investigate the enhancement of air side coefficients without a detrimental effect on air side pressure drop.

H. Investigate enhanced surfaces of tubing to improve heat transfer.

I. Investigate reducing pressure drop in refrigerant side components such as accumulators, mufflers, reversing valves, filters, and filter driers.

J. Develop methods to reduce the impact of frost formation on the performance of air coils.

K. Develop data and computational models for new approaches to heat transfer. An example is the possibility for direct contact heat exchange between refrigerants and the building cooling/heating media (e.g., water).

4. Unit and System Controls

A. Investigate how to effectively apply new advances in micro-electronic technology to HVACR units and systems.

B. Investigate improved expansion devices for refrigerant cycles.

5. Compressors

A. Investigate improved valves, sealing technology, and heat transfer between suction and discharge.

B. Investigate mechanisms for improving efficiency of variable speed compressors.

C. Investigate oil-less compressors and oil-free systems which would aid in the exploitation of new heat transfer surfaces.

D. Investigate liquid tolerant designs which would enable better use of evaporator surfaces currently devoted to superheating.

6. Materials

A. Develop new thermal insulating materials which are cost-effective and environmentally benign to replace CFC foam and asbestos insulation.

B. Consider possibilities for substantial improvements in performance of thermoelectric materials which may result from new understandings of the physics of materials in superconductivity research.

C. Evaluate the behavior of synthetic materials in the presence of refrigerants and under various temperature and lubrication conditions. For example, most nonmetallic materials are not tested for the kinds of fatigue life needed in compressors and refrigeration systems.

7. New Cycles

A. Continue research in absorption systems and other chemical processes for chillers and heat pumps driven by waste heat. Systems which do not use CFCs and systems which utilize waste heat effectively are both of interest.

B. Many good theoretical cycles exist but are not practical due to problems in implementation (e.g., Stirling Cycle, Rovac). New cycles are needed which are:

1) Inherently efficient;

2) Reducible to practical hardware without unacceptable loss of efficiency; and

3) Use a reasonably priced, benign working fluid.

C. Evaluate the potential of magnetic heat pumps for environmental control. This is a new technology still in the advanced research stage.

8. Thermal Storage Concepts/Materials

A. Investigate safe, non-toxic phase change materials or other storage methods with transition temperatures at levels close to desired cooling and heat rejection temperatures. Present methods (e.g., ice storage) entail energy losses because of temperature mismatches. A storage medium that is effective at 45°F is desirable, for example. High heats of fusion and vaporization are needed.

Work is needed on long-term stability of phase change materials, and on the development of various chemical heat storage systems. Possible research tasks would be to investigate those systems currently being looked at by the Japanese, including metathesis of olefins and catalytic organic reactions, inorganic hydrates, ammonium complex of salts, and salvation and hydration of aqueous mixtures.

III. BUILDING ENVIRONMENT

The third major focus of ARI's research plan is on building environment. This is a broad category, crosscutting all ARI product areas.

The goal for this research area is to improve and continuously sustain the comfort, health, and safety of building occupancy.

Objectives are to facilitate U.S. industry's improvement in:

1. **Indoor Air Quality**
2. **Temperature and Humidity Control**
3. **Noise Abatement**
4. **Air Distribution and Balance**

Work to improve indoor air quality is the most important research priority in the building environment area. This is an area of intense activity. Already legislation has been introduced on this subject and future regulation seems certain. The industry must prepare now in anticipation of future regulation, but more importantly to ensure that ARI products do not contribute to the problem.

In the areas of temperature and humidity control, air distribution and balance, and noise abatement, it is acknowledged that foreign competitors already have superior technology. There is a great deal more work which needs to be done for the U.S. industry to produce competitive technology.

Specific research should be completed to develop HVACR products consistent with the above goals and guidelines.

1. Indoor Air Quality

A. Continue research to determine limits for contaminants in indoor air and physiological boundaries for acceptable vs. unsatisfactory indoor environmental conditions. Define the tolerable levels and the pollutants that affect indoor air quality.

B. Develop technology for reliable, durable sensors for indoor environmental parameters and pollutants defined in the research above. Sensors are available today for temperature, humidity, air velocity, and certain contaminants. New sensors are needed for other parameters defined by the research above and for other pollutants.

C. Investigate ventilation cycles and distribution of indoor air to control pollutants.

D. Investigate active pollution removal devices for scrubbing indoor air.

E. Identify the causes and develop a means to eliminate the growth of mold and bacteria in the indoor side of air conditioning equipment.

F. Investigate improvements in energy efficiency through lower pressure drop air side filters with improved entrainment capabilities.

2. Temperature and Humidity Control

   A. Define human comfort in engineering terms. How much draft is too much? How closely do temperatures need to be controlled? What kinds of noise levels become objectionable under various conditions?

   B. Investigate improved humidity sensors, pressure transducers, and temperature sensors with longer life for use in air conditioning and distribution controls for efficient thermal control of conditioned spaces.

   C. Investigate innovative humidity control schemes with controls sequences and/or use of heat transfer enhancements.

   D. Investigate a fool-proof defrost system for heat pumps that will not penalize indoor air temperatures.

3. Noise Abatement

   A. Investigate mufflers, air foils, active filters, and suspension systems for sound control.

   B. Develop predictive methods for estimating sound levels for all environmental types of fans and blowers.

4. Air Distribution and Balance

   A. Develop a design approach for an integrated system that incorporates equipment, duct design, and diffuser design and location to provide optimum distribution and comfort. Investigate means to control air distribution and balance for zoned and variable air systems. Develop a more practical method of applying current theoretical data to actual application of air distribution and balance.

IV. OTHER RESEARCH AREAS

A. Understand how the utilities will view future operating systems, particularly systems that involve inverters and electronic devices. What sorts of incentives might utilities offer in the future? What kind of system operating parameters would be important to utilities?

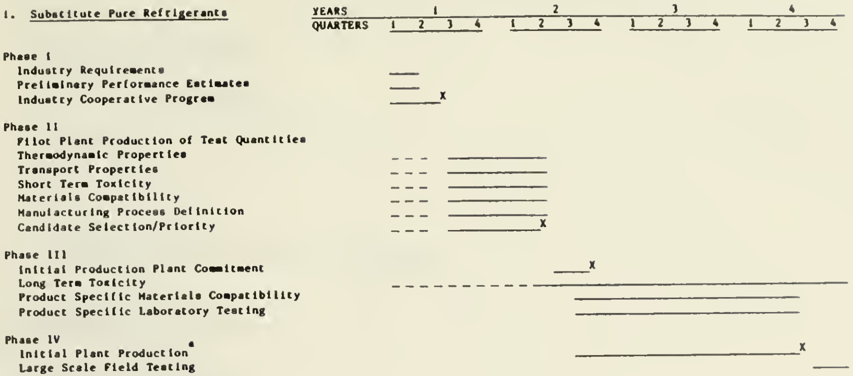
B. Explore means of placing research projects on a common basis to permit comparison of findings. Frequently, various types of refrigeration cycles will be analyzed, but under different conditions, and as a result there is no easy direct comparison.

C. Investigate means of providing improved compressor durability and reliability.

D. Standardize communication links and protocols used in equipment controls and energy management systems to allow users of equipment from various sources to optimize their system operation.

APPENDIX A

FIG. 1
CFC ALTERNATIVE REFRIGERANT TIME LINE



(Note: X represents milestones)

[a] Production of commercial quantities as opposed to test quantities.

FIG. 1
CFC ALTERNATIVE REFRIGERANT TIME LINE

2. Refrigerant Mixtures	YEARS	1				2				3				4			
	QUARTERS	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase I						___	X										
Industry Requirements																	
Preliminary Performance Estimates																	
Industry Cooperative Program																	
Phase II							detailed schedule to be determined										
Pilot Plant Production of Test Quantities																	
Thermodynamic Properties																	
Transport Properties																	
Short Term Toxicity																	
Materials Compatibility																	
Manufacturing Process Definition																	
Candidate Selection/Priority																	
Phase III																	
Initial Production Plant Commitment																	
Long Term Toxicity																	
Product Specific Materials Compatibility																	
Product Specific Laboratory Testing																	
Phase IV																	
Initial Plant Production[a]																	
Large Scale Field Testing																	

(Note: X represents milestones)

[a] Production of commercial quantities as opposed to test quantities.

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 134A (R12 Alternative) TASK	1988	1989	1990	1991	1992	1993	1994
1. Measure Thermodynamic Properties Participants: **CM, Government**		1					
2. Measure Transport Properties Participants: **CM, Government**		3					
3. Pilot Plant Production of Test Quantities Participants: **CM**	4						
4. Toxicity Testing Participants: **PAFT**, CM					1		
5. Materials Compatibility							
1. Initial Screening Tests	4						
2. Motor Insulation	4						
3. Metals	4						
4. Plastics	4						
5. Elastomers	4						
6. Filter-Driers		1					
7. Lubricants (solubility/lubricity) Participants: **EM**, Academia, Govt. CS, CM		2					
6. Laboratory Machine Testing Participants: **EM**		4					
7. Large Scale Field Trial Participants: **EM**					1		
8. Containment Procedures							
1. Transfer/Storage		1					
2. Reclamation		2					
3. Purging Participants: **EM**		4					
9. Leak Detection Participants: **EM**		3					
10. Mfg. Process Defined/Plant Commitment Participants: CM	2						
11. Plant Production Participants: CM			4				

Legend:
CM - Chemical Manufacturers
PAFT - Consortium for Alternate Refrigerant Toxicity Testing
TBD - To Be Determined
EM - Equipment Manufacturers
CS - Components Suppliers
In the participants section of each task, bolding indicates lead participant(s).

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 123
(R11 Alternative)

	TASK	1988	1989	1990	1991	1992	1993	1994
1.	Measure Thermodynamic Properties Participants: CM, Government, Academia		1					
2.	Measure Transport Properties Participants: CM, Government, Academia		3					
3.	Pilot Plant Production of Test Quantities Participants: CM, Govt., Academia	4						
4.	Toxicity Testing Participants: PAFT, CM					2		
5.	Materials Compatibility							
	1. Initial Screening Tests	4						
	2. Motor Insulation	3						
	3. Metals	3	4					
	4. Plastics	4						
	5. Elastomers		3					
	6. Filter-Driers		3					
	7. Lubricants (solubility/lubricity)	3						
	Participants: EM, Academia, Govt. CS, CM							
6.	Laboratory Machine Testing Participants: EM		4					
7.	Large Scale Field Trial Participants: EM					1		
8.	Containment Procedures							
	1. Transfer/Storage		1					
	2. Reclamation		2					
	3. Purging		4					
	Participants: EM							
9.	Leak Detection Participants: EM		3					
10.	Mfg. Process Defined/Plant Commitment Participants: CM		1					
11.	Plant Production Participants: CM				1			

Legend:
CM - Chemical Manufacturers
PAFT - Consortium for Alternate Refrigerant Toxicity Testing
TBD - To Be Determined

EM - Equipment Manufacturers
CS - Components Suppliers
In the participants section of each task, bolding indicates lead participant(s).

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 125
(R502 Alternative)

TASK	1988	1989	1990	1991	1992	1993	1994
1. Industry Requirements		1					
2. Measure Thermodynamic Properties Participants: CM, Government, Academia		2					
3. Measure Transport Properties Participants: CM, Government, Academia		4					
4. Pilot Plant Production of Test Quantities Participants: CM			4				
5. Toxicity Testing							
Short Term		4					
Long Term						2	
Participants: PAFT, CM							
6. Materials Compatibility							
1. Initial Screening Tests			2				
2. Motor Insulation			4				
3. Metals			4				
4. Plastics			4				
5. Elastomers			4				
6. Filter-Driers			4				
7. Lubricants (solubility/lubricity)			4				
Participants: EM, Academia, Govt. CS, CM							
7. Laboratory Machine Testing Participants: EM			4				
8. Large Scale Field Trial Participants: EM						3	
9. Containment Procedures							
1. Transfer/Storage			4				
2. Reclamation			4				
3. Purging			4				
Participants: EM, CM							
10. Leak Detection Participants: EM			4				
11. Mfg. Process Defined/Plant Commitment Participants: CM			4				
12. Plant Production Participants: CM					2		

Legend:
CM - Chemical Manufacturers
PAFT - Consortium for Alternate Refrigerant Toxicity Testing
TBD - To Be Determined

EM - Equipment Manufacturers
CS - Components Suppliers
In the participants section of each task,
holding lead (indic

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 124 (R114 Alternative) TASK	1988	1989	1990	1991	1992	1993	1994
1. Industry Requirements		1					
2. Measure Thermodynamic Properties Participants: CM, Government, Academia		2					
3. Measure Transport Properties Participants: CM, Government, Academia		4					
4. Pilot Plant Production of Test Quantities Participants: CM		4					
5. Toxicity Testing							
Short Term		4					
Long Term Participants: PAFT, CM						2	
6. Materials Compatibility							
1. Initial Screening Tests		4					
2. Motor Insulation			2				
3. Metals			2				
4. Plastics			2				
5. Elastomers			2				
6. Filter-Driers			2				
7. Lubricants (solubility/lubricity) Participants: EM, Academia, Govt. CS, CM			2				
7. Laboratory Machine Testing Participants: EM			4				
8. Large Scale Field Trial Participants: EM						3	
9. Containment Procedures							
1. Transfer/Storage			2				
2. Reclamation			2				
3. Purging Participants: EM			4				
10. Leak Detection Participants: EM			2				
11. Mfg. Process Defined/Plant Commitment Participants: CM			4				
12. Plant Production Participants: CM					2		

Legend:

CM -	Chemical Manufacturers	EM -	Equipment Manufacturers
PAFT -	Consortium for Alternate Refrigerant Toxicity Testing	CS -	Components Suppliers
TBD -	To Be Determined		

In the participants section of each task, bolding indicates lead participant(s).

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 32 (R502 Alternative)	1988	1989	1990	1991	1992	1993	1994
TASK							
1. Industry Requirements		1					
2. Measure Thermodynamic Properties Participants: **CM**, Government, Academia	1						
3. Measure Transport Properties Participants: **CM**, Government, Academia	TBD						
4. Pilot Plant Production of Test Quantities Participants: **CM**	TBD						
5. Toxicity Testing							
Short Term	TBD						
Long Term	TBD						
Participants: **PAFT, CM**							
6. Materials Compatibility							
1. Initial Screening Tests	TBD						
2. Motor Insulation	TBD						
3. Metals	TBD						
4. Plastics	TBD						
5. Elastomers	TBD						
6. Filter-Driers	TBD						
7. Lubricants (solubility/lubricity)	TBD						
Participants: **EM**, Govt., Academia, CS, CM							
7. Laboratory Machine Testing Participants: **EM**	TBD						
8. Large Scale Field Trial Participants: EM	TBD						
9. Containment Procedures							
1. Transfer/Storage	TBD						
2. Reclamation	TBD						
3. Purging	TBD						
Participants: EM							
10. Leak Detection Participants: **EM**	TBD						
11. Mfg. Process Defined/Plant Commitment Participants: CM	TBD						
12. Plant Production Participants: CM	TBD						

Legend:
CM - Chemical Manufacturers
PAFT - Consortium for Alternate Refrigerant Toxicity Testing
TBD - To Be Determined
EM - Equipment Manufacturers
CS - Components Suppliers
In the participants section of each task, bolding indicates lead participant(s).

TRANSITION TO CFC SUBSTITUTES
TASK COMPLETION DATE (BY QUARTERS)

REFRIGERANT 143A (R502 Alternative) TASK	1988	1989	1990	1991	1992	1993	1994
1. Industry Requirements		1					
2. Measure Thermodynamic Properties Participants: CM, Government, Academia		4					
3. Measure Transport Properties Participants: CM, Government, Academia			2				
4. Pilot Plant Production of Test Quantities Participants: CM	TBD						
5. Toxicity Testing							
Short Term			2				
Long Term						2	
Participants: PAFT, CM							
6. Materials Compatibility							
1. Initial Screening Tests	TBD						
2. Motor Insulation	TBD						
3. Metals	TBD						
4. Plastics	TBD						
5. Elastomers	TBD						
6. Filter-Driers	TBD						
7. Lubricants (solubility/lubricity)	TBD						
Participants: EM, Academia, Govt. CS, CM							
7. Laboratory Machine Testing Participants: EM	TBD						
8. Large Scale Field Trial Participants: EM	TBD						
9. Containment Procedures							
1. Transfer/Storage	TBD						
2. Reclamation	TBD						
3. Purging	TBD						
Participants: EM							
10. Leak Detection Participants: EM	TBD						
11. Mfg. Process Defined/Plant Commitment Participants: CM	TBD						
12. Plant Production Participants: CM	TBD						

Legend:
CM - Chemical Manufacturers
PAFT - Consortium for Alternate Refrigerant Toxicity Testing
TBD - To Be Determined
EM - Equipment Manufacturers
CS - Components Suppliers
In the participants section of each task, bolding indicates lead participant(s)

APPENDIX B

Organizations Involved in HVACR Equipment and Components Research

In 1988 the federal government spent at least $10 million on industry related research. This is allocated as follows:

Oak Ridge National Laboratory (ORNL) - $7 million

National Institute of Standards and Technology (NIST) - $1 million

Argonne National Laboratory - $1 million

The Environmental Protection Agency (EPA), the National Science Foundation and the Department of Defense (DOD) also carry out industry-related research. ARI has not yet determined the level of funding for this work.

In addition to federal government research, many private sector organizations like the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), and ASHRAE fund research on HVACR equipment and components. A number of universities perform research using funds provided by these sources. It is possible that ARI could cooperate with these groups on research matters.

A brief outline of ORNL, NIST, and EPRI HVACR research areas follows.

1. Oak Ridge National Laboratory

Oak Ridge is the principal government agency coordinating HVACR research. The Department of Energy has delegated to ORNL the administration of its building equipment research program. There are two major budget areas: thermally activated heat pumps and advanced refrigeration. Projects of interest to ARI members generally fall in the advanced refrigeration area.

1988 budget for HVACR research: approximately $7 million. (5.2 million for thermally activated research; $1.8 million for advanced refrigeration research.)

Major work in the advanced refrigeratin area:

1. Variable speed heat pumps for capacity modulation
    A. Design option analyses
        i) reciprocating compressors
        ii) rotary, scroll compressors

    B. Characterization of Japanese variable speed systems in heat pumps (2 1/2 ton)

    C. Computer design model development

2. Non-azeotropic refrigerant mixtures (NARMs)
    A. Alternative cycle characterizations (work carried out by NIST)
    B. Heat transfer improvement with NARMs
    C. Assessment of non-azeotropic refrigerant mixtures capacity leveling through composition control

3. CFC screening experiments examining potential of "drop-in" replacements for R-12 in refrigerators

4. CFC Alternatives (tentative)

2. National Institute of Standards and Technology (NIST)

1988 budget: Approximately $750,000

1. Non-azeotropic refrigerant mixtures (NARMs)
    A. Efficiency enhancement
    B. Advanced heat pump cycles using NARMs (with ORNL)
        i. Bread board tests
        ii. Computer modeling
2. Thermodynamic properties work on HFC 134A and HCFC 123 (with DOE, EPA, and ASHRAE)
3. Evaluation of non-azeotropic heat pump concepts (with EPRI)
4. Heat pump and air conditioner test and rating procedures (with DOE)
5. Evaporative flow heat transfer (with EPRI)

3. Electric Power Research Institute (EPRI)

1988 budget: Approximately $10 million

1. Heat Pump Research Program
    i. Reliability and field performance
    ii. Duel-fuel residential heat pump
    iii. Closed-loop water-source heat pumps
    iv. Duel-fuel rooftop heat pumps
    v. Component improvement

2. Residential Building Systems
    i. Residential HVAC technology and applications
    ii. Building performance

3. Commercial Building Systems
   i. HVAC
   ii. Refrigeration
   iii. Appliances

4. Load Management Technology
   i. Cool storage
   ii. Heat storage
   iii. Controls/Automation

5. Supermarket Refrigeration

For each of the organizations mentioned above, ARI must investigate its capability to carry out research projects on refrigerants, energy and building environment.

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TELEPHONE 342-2859
AREA CODE 703

May 25, 1989

Senator J. Bennett Johnston
Room 136 Hart Senate Office Building
Washington, D.C. 20510

Attention: Mr. Benjamin S. Cooper

Dear Senator Johnston:

This letter follows a meeting with Mr. Ben Cooper on May 24, 1989 regarding the use of sweet sorghum and sugar cane bagasse in small power producing systems. The discussion was primarily about research with sweet sorghum bagasse in a biomass fueled gas turbine power generating system at Red Boiling Springs, Tennessee. Sweet Sorghum, a prolific, drouth resistant crop which can supply sugar for alcohol, feed for livestock, and bagasse for fuel can be grown in any of the contiguous 48 states. Small biomass fueled gas turbine power plants (3 to 30 megawatts) can be placed in any rural location where their is a biomass fuel supply and a power transmission line to wheel the power out. Power generated by this means will result in no net increase in carbon dioxide in the atmosphere, nor will the alcohol used in automobile fuel.

One immediate result of the research would be the ability to use sugar cane bagasse more efficiently. A gas turbine can follow the load demand for power and can be shut down during off-peak periods. The large volumes of 800°F exhaust gases can be used for both drying the bagasse and processing the juice. The installed cost per kilowatt hour for the gas turbine system is half that for a steam system.

The three megawatt biomass fueled system at Red Boiling Springs, the only such system in the world, is currently being operated on sawmill waste. Additional funds are needed to continue the research on both wood and bagasse. The attached information provides more detailed information on the system. We would appreciate your support for research funding on this project.

Very truly yours,

AEROSPACE RESEARCH CORPORATION

Joseph T. Hamrick
President

JTH/cd
Enclosures

TENNESSEE TECH
UNIVERSITY
Tennessee Technological University
College of Agriculture and Home Economics
School of Agriculture
Box 5034 . Cookeville, TN 38505 . 615-372-3019
3120

May 29, 1989

Mr. Joseph T. Hamrick
Aerospace Research Corporation
5454 Aerospace Road
Roanoke, VA 24014

Dear Mr. Hamrick:

I appreciate your sending to me a copy of your proposal to utilize sweet sorghum bagasse as an alternative fuel for gas turbines and for inviting me to assist you on the project. Prior to accepting my position at Tennessee Technological University in the Fall of 1986, I had worked with the production of sweet sorghum and several other herbaceous crops as renewable energy sources at Auburn University, Auburn, AL, for 10 to 12 years. During my last two years there, I was a co-project leader with Dr. C. Y. Ward on a herbaceous biomass crops project funded by Martin Marietta, Oak Ridge National Laboratory, at the rate of $125,000 per year. Sweet sorghum was the crop which we identified as having the greatest potential as a herbaceous energy crop from an agronomic standpoint. Incidentally, Virginia Tech, Purdue, Cornell, and Geophyta (a private company) had similar contributing projects. The intriguing feature of your proposal to me is the opportunity to evaluate the actual conversion of the juice and bagasse into an energy product. This is the missing link that was lacking in our evaluations and a vital area that must be explored.

I had a very profitable and informative visit with Mr. Randal Gregory Friday afternoon. I was favorably impressed with the facility which you have designed, constructed, and placed in operation at Red Boiling Springs, TN. It seems ideally suited to test the feasibility of using sweet sorghum bagasse as an energy source for the gas turbines. Evidently sufficient excess heat is available to concentrate the sweet sorghum juice for safe storage prior to converting it to alcohol at the site or reducing shipping cost to a more distant alcohol plant.

I have discussed the basic ideas of your proposal and how the School of Agriculture can contribute to its goals with my Director and Dean and the Vice-President for Research. They are supportive of us investigating the mutual benefits that our programs can accrue from such an arrangement. Tennessee Tech also has a Research Center of Excellence for Electric Power which could also add strength to the assistance that you can obtain from us.

I am enclosing a copy of my resume' for your information. Please contact me if you need additional information from me.

Sincerely,

C. Cooper King, Jr.

C. Cooper King, Jr.
Professor

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ROLE OF SWEET SORGHUM AND THE BIOMASS FUELED GAS TURBINE IN AVERTING THE ENERGY AND WARMING TREND CRISIS

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The United States is faced with the prospect of depleting its proven petroleum reserves within eight years and a twenty percent increase in electrical power demand in ten years. Without some preventative action during this period the U.S. can become heavily dependent upon the petroleum exporting countries for oil, and will create an unacceptable increase in carbon dioxide emissions from fossil fuels in the generation of electric power.

Sweet sorghum, a drouth resistant crop the production of which has been heavily researched by the U.S. and State Departments of Agriculture in cooperation with the U.S. Department of Energy can provide all of the energy for the increased power demand and a significant percentage of the demand for automobile fuel. This renewable fuel will result in a zero net increase in carbon dioxide. Based on the published research results for sweet sorghum, the 53.3 million acres taken out of production in 1988 can supply the energy needed for 18 of the 20 percent increase in needed power. The annual payment for setting the land aside is estimated to be over $5 billion. Much more additional acreage can be easily devoted to sorghum as an alternative crop. Besides providing fuel for electric power the grain and sugar can produce enough alcohol fuel to supply approximately sixteen percent of the energy supplied from imported oil. Intensive cultivation of sugar cane and sorghum in states bordering the Gulf of Mexico can result in tripling these outputs.

The two power generating systems that can be used to convert sorghum or sugar cane bagasse to electrical energy are the steam turbine and gas turbine. While research on both small steam systems and gas turbines is needed, the gas turbine system has been selected for research by Aerospace Research Corporation because it offers at least three distinct advantages over the steam system which are as follows:

1. Gas turbines have the ability to follow load demand and can be conveniently shut down in offpeak demand periods when the price paid for the power is generally less than the cost to produce it. Steam systems cannot be economically shut down. Periods of peak demand occur only 36 to 44 percent of the time in most areas.

2. The high temperature, high volume gas turbine exhaust gases (800°F) are adequate to concentrate the juice and to dry the bagasse for year round storage and use. Exhaust gases from steam systems which are low in volume and temperature (350°F) are not adequate to do so.

3. Gas turbine systems cost under half that of steam systems per kilowatt output. Gas turbine systems can be mass produced and moved into place in a matter of weeks.

Small biomass fueled gas turbine power plants (3 to 30 megawatts) can be placed in any rural location however remote, where there is a biomass fuel supply and a transmission line to wheel the power out. Badly needed jobs can thus be provided in rural areas as well as alternative crops.

The three megawatt biomass fueled research system at Red Boiling Springs, Tennessee, the only such system in the world, is currently being operated on sawmill waste. Additional funds are needed to continue the research on wood and bagasse. The Department of Energy, which is currently funding millions ($22.8 million in fiscal 89) for coal burning gas turbine and diesel engine research has discontinued funding for this biomass burning gas turbine research and has made a policy decision to provide no funding for thermochemical conversion of biomass to electric power. Congressional help is being sought to modify that decision.

Currently, the Minnesota Legislature is funding $512,000 in that state for research on sweet sorghum as an alternative crop for fuel alcohol, livestock feed, and fuel for electrical power generation. The state of California has set aside $160,000 to assist farmers in experimenting with sweet sorghum as an alternative crop, and a Joint Resolution is before the California Senate requesting that farmers be permitted to grow energy crops on the 3,084,714 acres now out of production and costing in excess of $285,560,000. Agriculture researchers at Virginia Tech are in their ninth year of research on sweet sorghum as an alternative crop for feed and energy. Of the organizations concerned with agriculture and energy in the ten states that have been contacted there is solid support for use of sorghum as an energy fuel and research on the gas turbine for use of biomass.

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June 20, 1989

The Honorable J. Bennett Johnston
United States Senate
136 Hart Senate Office Building
Washington, DC 20510

Dear Senator Johnston:

I am writing on behalf of the American Public Power Association, the national organization representing 1,750 locally owned public power systems to ask that you support S. 488, the Renewable Energy and Energy Efficiency Technology Competitiveness Act, when it comes before the Energy and Natural Resources Committee.

Public Power has made a commitment to energy efficiency and renewable energy as key components of a policy to provide consumers with reliable energy services at affordable prices. S. 488 would provide modest but significant support for such a sensible energy policy. The bill would authorize additional funding for energy efficiency and renewable energy on a multi-year basis, would expand public-private cooperation on research, development, and demonstration of key technologies, and would assist the domestic industry's competitive position in international markets.

I hope you will support S. 488 when it comes before the Energy Committee for markup.

Sincerely,

Randy Swisher

Randy Swisher
Legislative Representative

RS:is

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